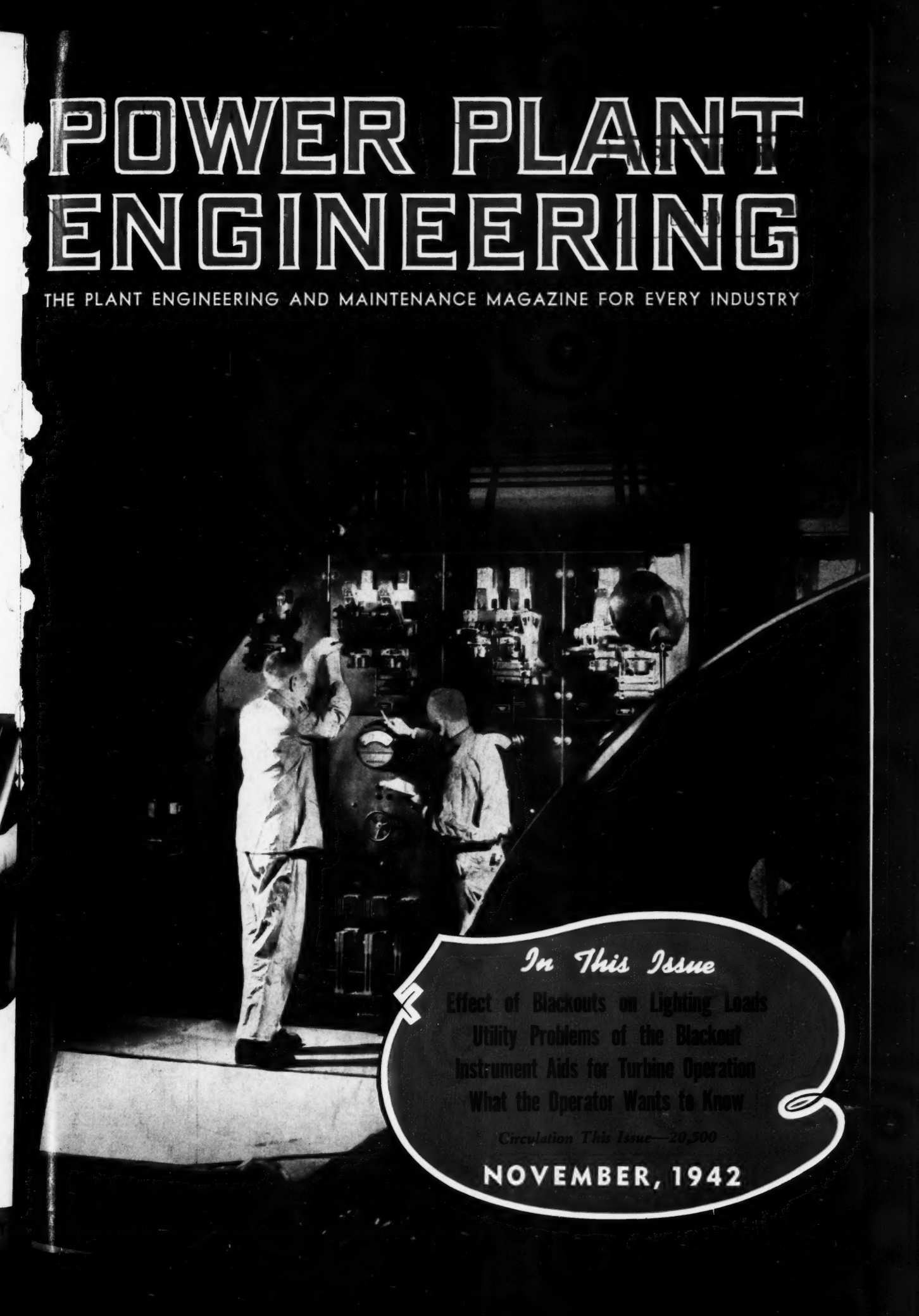
POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



In This Issue

Effect of Blackouts on Lighting Loads

Utility Problems of the Blackout

Instrument Aids for Turbine Operation

What the Operator Wants to Know

Circulation This Issue—20,500

NOVEMBER, 1942

Something sensational i

ELLIOTT

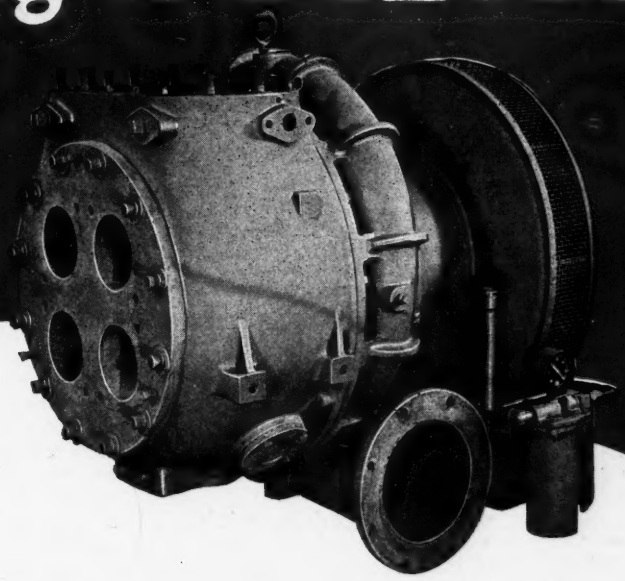
BUCHI

Exhaust Gas

TURBO-CHARGERS

Above is shown how the Elliott-Buchi exhaust gas turbocharger is normally mounted on a representative Diesel. The engine in the photo is an Enterprise model DMG-36 full Diesel, direct reversible, marine propulsion engine.

...happening to DIESELS!



with

TURBOCHARGING
of 4-Cycle Diesel Engines

UP TO 50% MORE B. HP. without increasing engine size . . . and IMPORTANT FUEL SAVING at all loads — up to 25% at ¼ load. This is what Elliott-Buchi turbochargers are doing for Diesels in the stationary, marine, and locomotive fields. The above figures are based upon over two million b.hp. of Diesels now equipped with the Buchi system. They admit of no question.

The turbocharger is driven by the engine exhaust (normally wasted power). The engine load (the volume of exhaust) automatically regulates the speed of the turbocharger and thus controls the volume of air supplied to the engine. No other controls required. In the locomotive and marine field it is important to note that engine reversal does not mean reversal of the turbocharger, since the exhaust flow is unidirectional.

Elliott-Buchi turbochargers are built for turbocharged 4-cycle engine ratings above 250 hp. They can be applied with savings to existing Diesels, but naturally achieve best results in Diesels designed for turbocharging.

We are glad to answer your specific questions on turbocharging, with complete data. Write us.

Hundreds of Elliott-Buchi turbochargers are now being built for the U. S. Navy and other war services

M-56

ELLIOTT COMPANY

Supercharger Dept., JEANNETTE, PA.

DISTRICT OFFICES IN PRINCIPAL CITIES

how to get the most service

For plants operating moderately-sized and smaller steam generating units. High-pressure, high-temperature units with fully water-cooled furnaces require special consideration.

If your steam generating units include superheaters, it is well to remember that this important equipment, too, requires care and attention if it is to deliver the trouble-free service for which it was designed. All too frequently, the superheater, hidden away among the boiler surfaces, is deprived of the attention normally given to the boiler and firing equipment. Don't wait for erratic performance or an actual failure of a superheater element to warn you of the necessity of correct operation and regular care of your superheaters.

OPERATION

So long as there is a fire in the furnace of a superheater-equipped boiler unit, adequate protection must be provided for the superheater. This is especially important when there is normally no demand for steam such as when starting up and shutting down. Most warpage of superheater elements and many of the failures occur as a result of improper operation during these periods.

The manufacturers provide suitable means for assuring this protection by supplying drain valves on the headers and safety valves on the outlet header. However, the purpose and use of these valves must be thoroughly understood and they must be properly operated to assure full protection. Recommended procedure follows.

There are three periods of operation during which the superheater must be given special attention: starting up, bringing the boiler on the line, and banking the boiler or shutting down.

(1) When starting up be sure the drain valve on the superheated-steam header has a free blow to the atmosphere through piping not smaller in size than the valve. This line should be independent of the boiler blowdown line, and should not discharge at a location that would make the escaping steam dangerous or disagreeable to the operators.

(2) When bringing the boiler on the line be sure that the saturated steam header drain is closed and the superheated steam header drain is open until the boiler is cut in on the line, whereupon the latter drain should be closed also. Steam must flow through the superheater elements at all times so as to maintain element temperatures within the limits for the metals used.

(3) When banking a boiler for standby service it is recommended that the superheated-steam header drain valve be opened to provide an adequate flow of steam through the superheater until furnace gas temperature has been sufficiently reduced to assure its protection. This is especially desirable where frequent banking periods are required.

(4) The purpose of the safety valve on the superheated-steam header (set from 3 to 5 lb below the lowest set boiler safety valve) is to assure adequate steam protection to the superheater if the steam demand drops suddenly and unexpectedly. When this occurs, reduce the firing rate immediately to conform with load requirements as the superheater safety valve is usually not designed to maintain safe steam temperatures indefinitely.

CLEANLINESS

Where conditions require that units be kept in service for extended periods, it is essential that suitable arrangements be made to assure cleanliness of the external superheater surfaces. This may be accomplished by properly located soot blowers or by hand lancing with air at regularly scheduled intervals. Dust accumulation results in unequal gas distribution, inefficient heat transfer and possibly localized overheating.

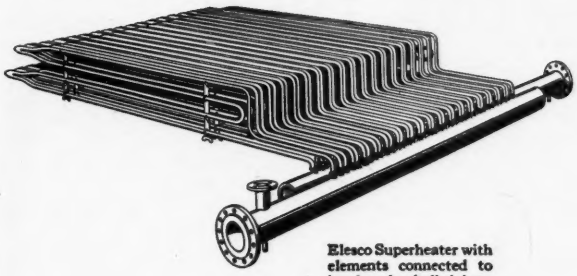
Proper feedwater treatment and control of steam quality and carry-over are essential to assure cleanliness of interior surfaces of superheaters. Overloads, fluctuating load, high water level, foaming, high concentrations, etc. all contribute to deposits on interior surfaces. Accumulation of these deposits cuts down heat transfer and increases pressure drop across the superheater. Unless dealt with effectively, ultimate failure of elements may occur. Consult manufacturer for corrective recommendations.

Periodic checks of steam pressure drop across the superheater will usually indicate whether or not solid deposits are present within the elements. A single pressure gage connected to both inlet and outlet headers and fitted with valves in both lines provides a simple method. Readings must be taken under identical load conditions.

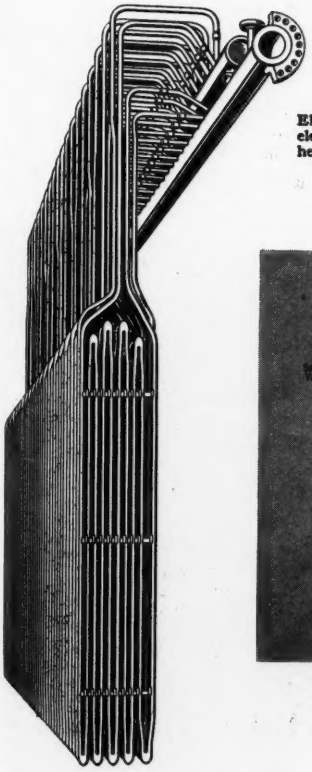
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS, AND AIR HEATERS

COMBUSTION

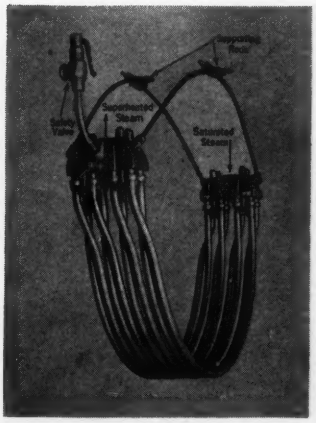
...e out of your superheaters!



Elesco Superheater with elements connected to headers by ball joints.



Elesco Superheater with elements connected to headers by welded joints.



Elesco Girth Superheater designed for Horizontal Return Tubular Boilers.

INSPECTION AND MAINTENANCE

A regular inspection and maintenance program conscientiously followed will do much to assure continuity of service and to avoid serious and expensive outage. A supply of spares on hand is good insurance against prolonged outage for repairs.

In the event of the failure of one or more elements, it is well to check carefully to determine the cause. The manufacturer will be glad to assist you and to suggest proper means to prevent recurrence.

The following inspection and maintenance routine is recommended.

(1) The superheater should always be inspected when the boiler is inspected.

(2) Check the elements for alignment and any evidence of warping or bulging. Replace as promptly as possible elements that show serious warping, bulging or other evidence of overheating.

(3) Check supports, spacers, baffling and seal plates for proper location and condition. Repair or replace promptly.

(4) Check joints at headers for tightness. Eliminate leaks promptly to avoid damage to seats.

(5) Check inside surfaces of headers and steam drum for evidence of solids carry-over. If present, take immediate steps to eliminate cause. When in doubt consult manufacturer.

(6) Check location and condition of soot blowers in immediate vicinity of superheater elements. Make sure that nozzles are in proper alignment and that the correct steam pressure is being used so that steam jets are not cutting the superheater elements.

There is no place in the Victory Program for idle equipment, particularly enforced outages due to careless operation and inadequate attention. Keep *your* units "on the line" through proper operation, regular inspection and prompt maintenance.

Over 100,000,000 boiler hp in the stationary, marine and locomotive fields have been equipped with Elesco Superheaters.

Reprints of this advertisement are available upon request.

A-484

COMBUSTION ENGINEERING COMPANY, INC., 200 MADISON AVENUE, NEW YORK, N. Y. • CANADA: COMBUSTION ENGINEERING CORPORATION, LTD., MONTREAL

ENGINEERING

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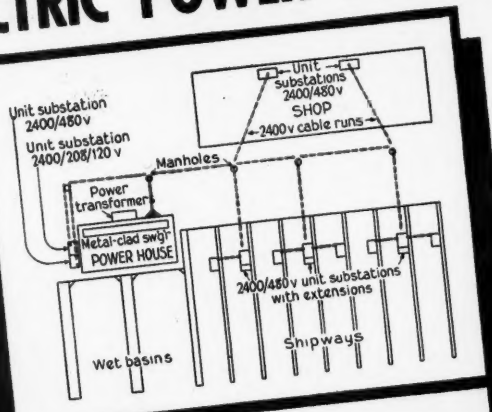
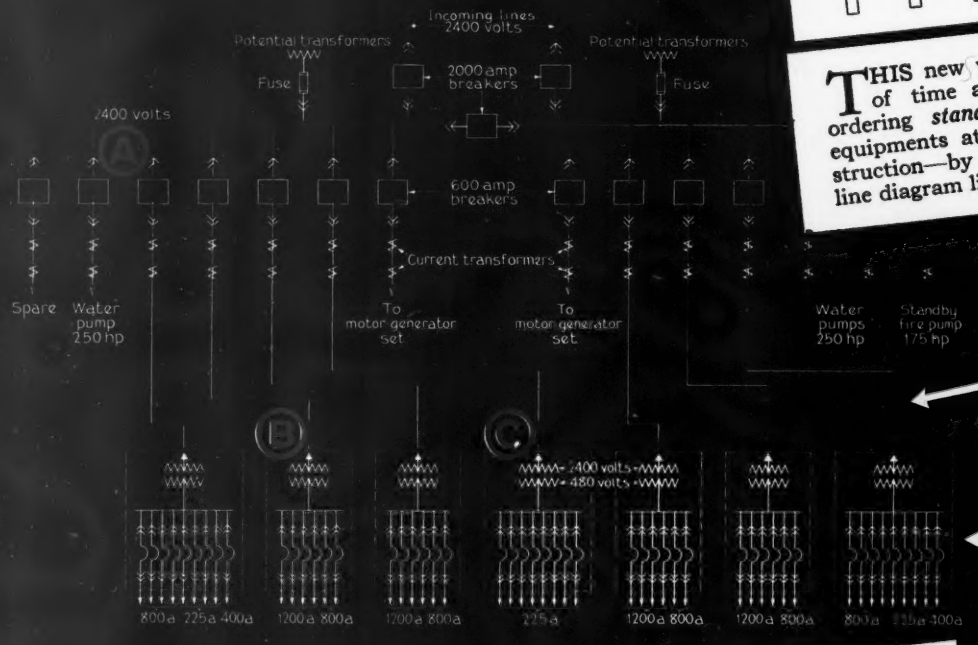
1/4 THE TIME 1/7 THE COPPER

AND A BETTER ELECTRIC POWER SYSTEM



THIS new war plant saved months of time and tons of copper by ordering *standard* power distribution equipments at an early stage of construction—by means of a simple one-line diagram like that below.



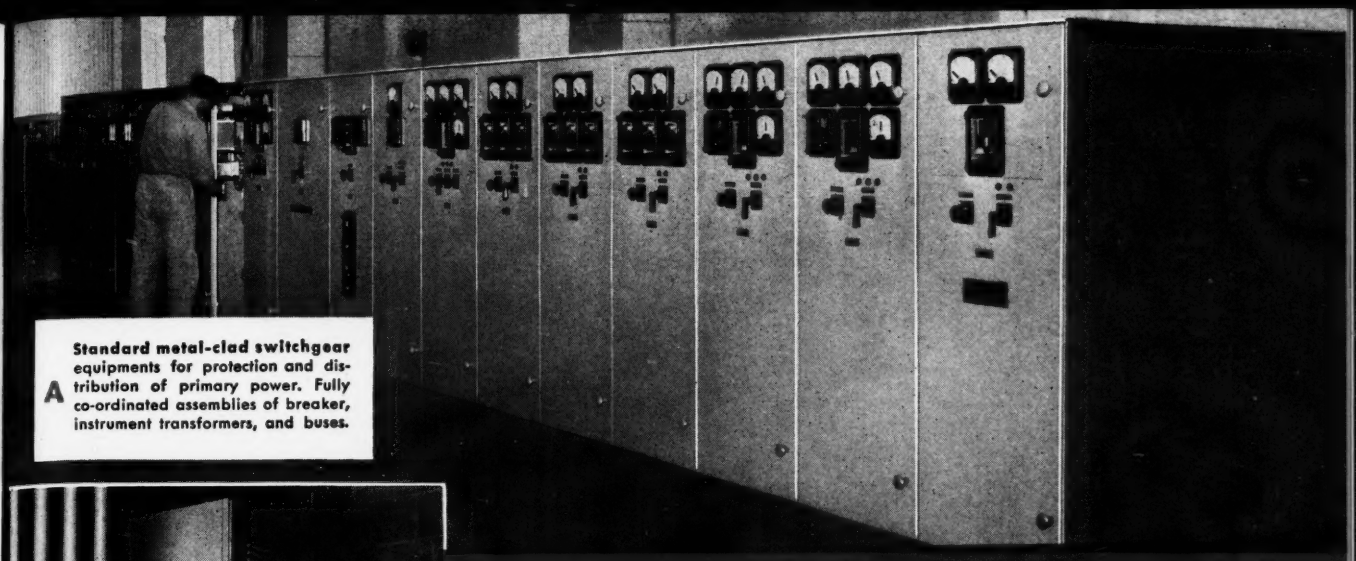
Many war-production factories are ordering plant distribution equipments at an early stage of construction by taking these three simple steps:

1 *Calculate the total kva you need.* Your consulting engineer can help you to determine this accurately.

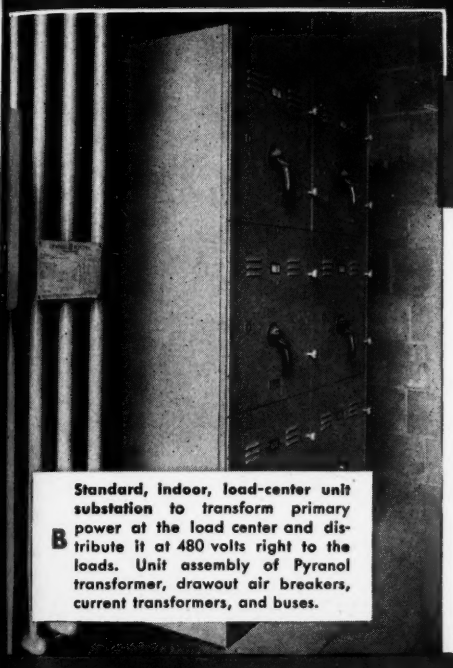
2 *Divide the load area into separate load zones of 500, 750, or 1000 kva each.*

3 *Divide the load of each zone into feeder loads,* and draw a one-line diagram of your proposed load-center system, giving the functions to be performed and the ratings required. *With this one-line diagram you can immediately order standard G-E switchgear equipments and unit substations.*

For further aid, ask for our new bulletin, No. GED-1006.



A Standard metal-clad switchgear equipments for protection and distribution of primary power. Fully co-ordinated assemblies of breaker, instrument transformers, and buses.



B Standard, indoor, load-center unit substation to transform primary power at the load center and distribute it at 480 volts right to the loads. Unit assembly of Pyranol transformer, drawout air breakers, current transformers, and buses.

MONTHS SAVED BY ORDERING STANDARD EQUIPMENTS

STANDARD G-E load-center power units were ordered for this war plant soon after construction started. A simple one-line diagram like that at the left put our factory right to work. Metal-clad switchgear and unit substations were installed in *one-fourth* the time needed for non-standard, piecemeal assemblies. They were received at the job when needed—all ready to be set in place and connected.

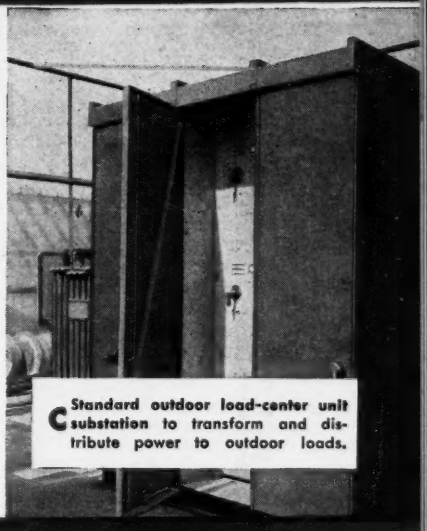
On this page are views of a few of these standard equipments—installed. They are typical of G-E load-center equipments that are being installed quickly and easily in plants everywhere. Note the metal-enclosed construction that safeguards workmen and production.

SAVED 145 TONS OF COPPER WITH LOAD-CENTER POWER DISTRIBUTION

ENGINEERS for this new war plant saved 145 tons of cable copper by taking high-voltage power right to the load centers, as shown at the left. In addition, they got a power distribution system that was so safe and efficient that, when need for additional capacity suddenly arose, they ordered another, a ***duplicate*** system—and saved another 145 tons of copper.

What's more, it took less copper to ***build*** these standard metal-clad units. The switchgear equipments shown at the top of this page took but 47 pounds of copper each. An open-type, piece-meal assembly would have taken more than four times as much.

If you need electric power for a new, enlarged, or converted war plant, we know you'll be pleased to learn how much copper and other critical materials you can save by using these standard load-center equipments. You'll find, too, that you can get them on the job quickly, and obtain a new high degree of safety and operating dependability. The nearest G-E office is ready to help you. ***General Electric, Schenectady, New York.***



C Standard outdoor load-center unit substation to transform and distribute power to outdoor loads.

GENERAL ELECTRIC

MORE STEAM? Here is what you get with Hagan Automatic Combustion Control

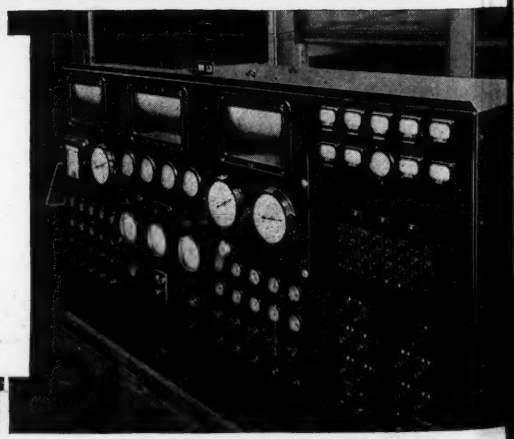
MAXIMUM QUANTITY of steam from any given plant, by introducing fuel and air in correct proportion for utmost efficiency.

MAXIMUM UTILIZATION value, uniform steam pressure and temperature, in accordance with demand.

MAXIMUM OUTPUT from boilers of differing capacities, automatically.

MAXIMUM STEAM for production, by reducing loss of steam in frequent soot-blowing.

MAXIMUM PROTECTION of auxiliary equipment, fans, stokers, etc., by maintenance of uniform operating conditions.



WHEN HEADQUARTERS KEEPS CALLING FOR MORE STEAM

IF you are doing everything you know how to step up the efficiency of your boilers and still fail to get a maximum output of steam, something is definitely lacking.

That "something" has proved in thousands of cases to be nothing more or less than *adequate* combustion control.

Because, regardless of other means employed to increase boiler capacity, Hagan Control, by adjusting all auxiliaries for maximum output, will insure the maximum of steam from every pound of fuel.

This is due to design superiority—rigid adherence to the sound principles pioneered by Hagan. If Hagan owes its wide acceptance by the power leaders of industry to any one thing, it is to the performance standards which are like law itself to Hagan engineers.

Every Hagan owner places complete reliance on the "mechanical brain" of the Hagan Control System. He knows it is never off the job—that it will do the work for which it was made with matchless, instantaneous precision.

Maybe you never have seen a plant operate under control like that. Maybe you didn't think it possible you could have such freedom from operating worries, such assurance of maximum results.

Then you should talk with a Hagan Combustion Specialist because he has the answers.

There is still time, fortunately. It is not too late to join the ranks of wartime producers who "when headquarters call for *more* steam" know they'll be able to produce it. Write, phone or wire for complete information about Hagan Control.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

READ THIS 5-YEAR RECORD OF A-E-CO TAYLOR STOKERS

ANOTHER CASE IN THE MUNICIPAL PLANT FIELD

PROBLEM:

The problem at this plant was three-pointed. First, there was the selection of firing equipment capable of operating efficiently over a wide steaming range. Second, equipment able to meet sudden increases in steam demands. The third requirement was an ability to bank economically and operate at light loads without difficulties of flame stability and ignition.

RESULTS:

During the five-year period from 1937 to 1941 inclusive 4,133,528,000 lbs. of steam were generated from 200,579.5 tons of coal averaging 13,039 BTU per pound coal as fired. Average actual evaporation 10.3 lbs. steam per lb. coal. Operating conditions were 385 lbs. gauge pressure, 715°F. steam temperature, and 305°F. feed temperature to economizer. Preheated air temperature 280°F.-310°F.

SOLUTION:

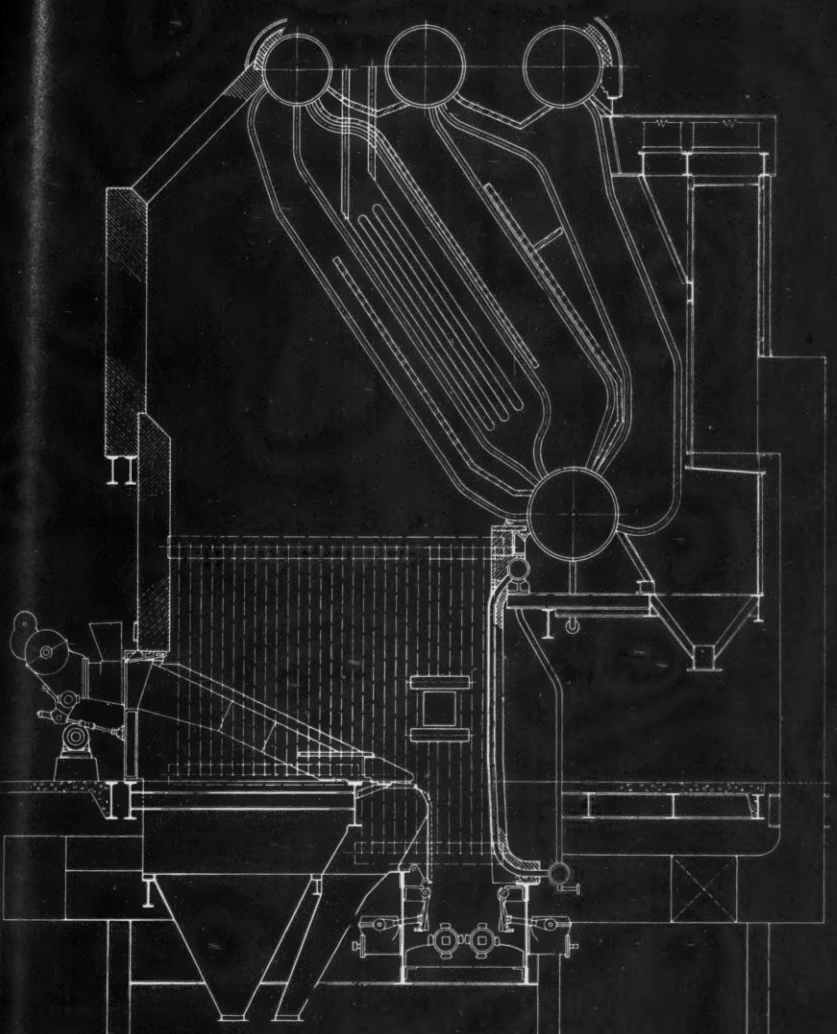
Three Taylor Stoker-fired Steam Generators were installed after a careful study of all feasible types of equipment. The capacity of each unit was 85,000 lbs. steam per hour. Several years later a similar unit of 125,000 lbs. capacity was added to the existing equipment.

CONCLUSIONS:

The average efficiency of 86.6% recorded over a full five-year period demonstrates once again the inherent ability of the Taylor Stoker to realize the highest operating economy in coordination with modern furnace design and modern heat recovery equipment.

AMERICAN ENGINEERING

PHILADELPHIA • PENNSYLVANIA



A-E-CO TAYLOR STOKERS ON THE FIRING LINE

*Aluminum Company of America, Edgewater, N. J.
*Aluminum Company of America, New Kensington, Pa.
American Tobacco Co., Inc., Durham, N. C.
Canmaker Paper Company, Johnsonburg, Penna.
Chrysler Corporation, DeSoto Plant, Detroit, Mich.
*Collins and Aikman Corp., Roxboro, N. C.
City of Columbus, Ohio
*Consolidated Paper Company, Monroe, Michigan
*Cresson State Sanitarium, Cresson, Penna.
Defiance Milk Products Co., Defiance, Ohio
*DeLaval Steam Turbine Co., Trenton, N. J.
*Detroit Sulphite Pulp & Paper Co., Detroit, Michigan
City of Dover, Ohio
*Draper Corporation, Hopedale, Mass.
Erwin Cotton Mills Co., West Durham, N. C.
*Fisher Body Corporation, Detroit, Michigan
Fisher Body Corporation, Fleetwood Plant, Michigan
*Fisher Body Corporation, Grand Rapids, Michigan
*Fisher Body Corporation, Pontiac, Michigan
Fox Paper Company, Lockland, Ohio
Froedtert Grain and Malting Co., Milwaukee, Wisc.
*City of Galion, Ohio
*Gardner-Richardson Company, Lockland, Ohio
*General Electric Company, Erie, Penna.
*General Electric Company, Fort Wayne, Ind.
*Greenwood Electric L. & W. Plant, Greenwood, Miss.
*Hazard Public Works, Hazard, Ky.
Hill School, Pottstown, Penna.
*Hobart Mfg. Co., Troy, Ohio
*City of Holland, Michigan
*Hope Natural Gas Co., Cornwell Station, West Va.
Hudepohl Brewing Co., Cincinnati, Ohio
Industrial Cotton Mills, Rock Hill, S. C.
*City Water & Light Plant, Jonesboro, Ark.
Kohler Company, Kohler, Wisc.
Maryland State Penal Farm, Roxbury, Md.
*Maybury Sanitarium, Northville, Michigan
Michigan Carton Company, Battle Creek, Michigan
*Michigan State College, East Lansing, Mich.
Municipal Light Plant, Marshfield, Wisc.
*Pacific Mills, Lyman, S. C.
*Packard Motor Car Co., Detroit, Michigan
*Municipal Electric Plant, Painesville, Ohio
*Park Drop Forge, Cleveland, Ohio
*Pennsylvania Electric Co., Seward, Penna.
*Pennsylvania R. R. Co., Philadelphia, Penna.
*Picatinny Arsenal, Dover, N. J.
*Pittsburgh Plate Glass Co., Barberton, Ohio
Borough of Quakertown, Quakertown, Penna.
Raleigh Wyoming Mining Co., Glen Rogers, W. Va.
*Rhinelander Paper Company, Rhinelander, Wisc.
City of Richland Center, Wisconsin
*City of Richmond, Indiana
Sayles Biltmore Bleachery, Biltmore, N. C.
Scotten Dillon Company, Detroit, Michigan
Shelby Cotton Mills, Shelby, N. C.
Sloane-Blabon Corp., Philadelphia, Penna.
Solvay Process Company, Detroit, Michigan
*St. Elizabeth's Hospital, Washington, D. C.
City of St. Bernard, Ohio
Swarthmore College, Swarthmore, Penna.
*Timken Roller Bearing Co., Canton, Ohio
Timken Roller Bearing Co., Gambrinus, Ohio
Municipal Water & Light Plant, Tippecanoe City, O.
City of Toledo, Ohio
*Union Bleachery, Greenville, S. C.
Union Mills Paper Mfg. Co., New Hope, Penna.
*University of Wisconsin, Madison, Wisc.
*Vassar College, Poughkeepsie, New York
*Borough of Vineland, New Jersey
Warfield Natural Gas Company, Harold, Kentucky
White Sewing Machine Co., Cleveland, Ohio
Whiting Plover Paper Company, Stevens Point, Wisc.

(*) Represents repeat orders.

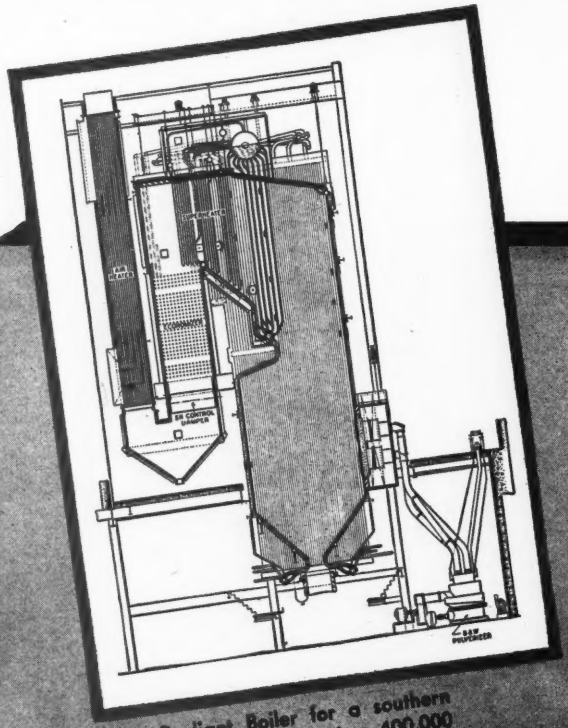
A-E-CO TAYLOR STOKER

A-E-CO TAYLOR STOKERS
WATER WALLS · ASH HOPPERS
HELE-SHAW FLUID POWER
MARINE DECK AUXILIARIES
LO-HED HOISTS

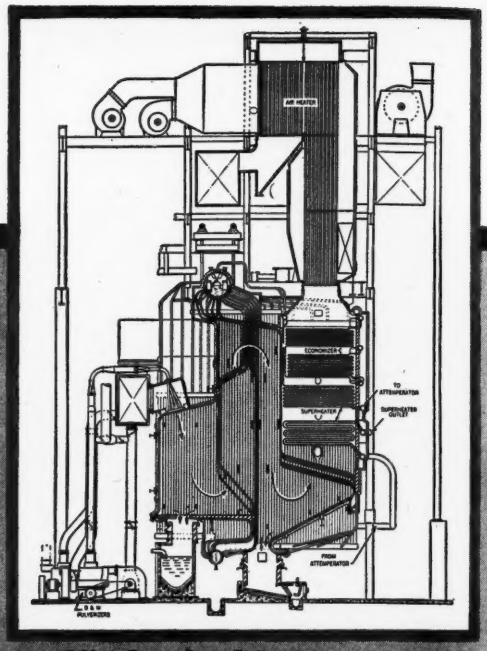
COMPANY

BEFORE YOU BUY ANY FUEL FIRING EQUIPMENT CONSIDER EACH OF THESE 12 FACTORS

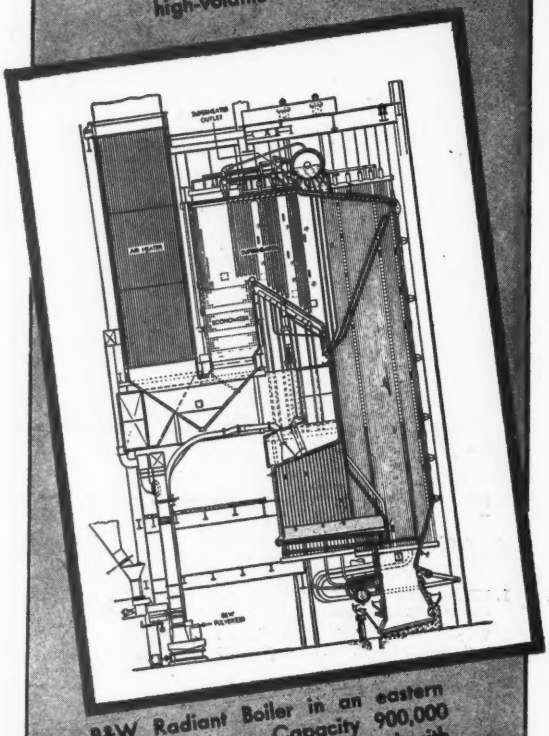
1. **RELIABILITY**—the ability to operate with minimum outage and minimum standby equipment.
2. **CAPACITY**—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.
3. **MAINTENANCE**—the ability to operate continuously with minimum repair costs.
4. **FLEXIBILITY**—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.
5. **EFFICIENCY**—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.
6. **OPERATION**—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.
7. **ADAPTABILITY**—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.
8. **FUEL FLEXIBILITY**—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.
9. **REFUSE DISPOSAL**—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.
10. **STACK DISCHARGE**—the practical elimination of "smoke nuisance", without special equipment.
11. **SPACE REQUIREMENTS**—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.
12. **OBSOLESCENCE**— the adaptability of the equipment toward possible future modernization with minimum of complication and outage.



B&W Radiant Boiler for a southern central station — Capacity 400,000 lb. steam per hr. — Direct fired with high-volatile southern bituminous coal.



B&W Open-Pass Boiler in an eastern central station — Capacity 350,000 lb. steam per hr. — Direct fired with high-volatile eastern bituminous coal.

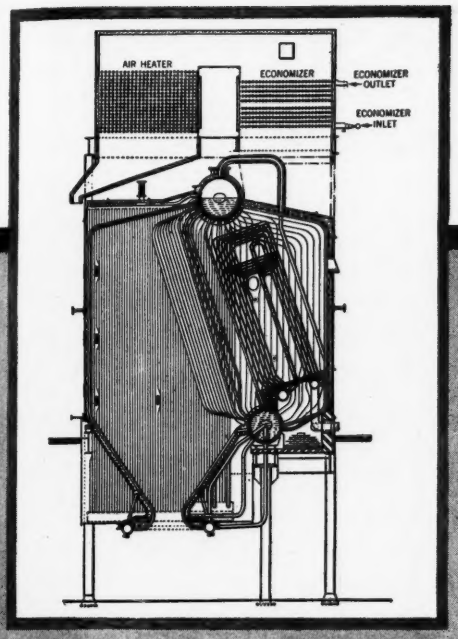


B&W Radiant Boiler in an eastern central station — Capacity 900,000 lb. steam per hr. — Direct fired with high-volatile eastern bituminous coal.

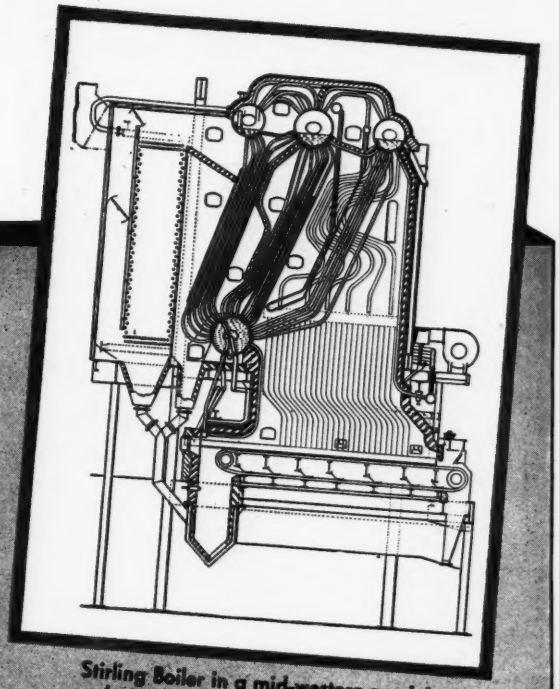
COAL MEETS THE
Pulverized and

Steam plants today must be operated in the interest of the war effort, releasing from use the fuels needed by combat units. This has placed on coal the burden of carrying today's production load. With coal, as with other fuels, it is vital that it be burned economically and with minimum interruption to service. In the field of coal burning, B&W can be of great service to coal users, because of its invaluable knowledge and experience in the combustion of this and other fuels and through the coal-burning equipment it has made available.

The B&W Direct-Firing System is the result of the Company's lengthy experience with pulverized-coal firing, an experience that dates back to the earliest applications to power boilers. This system is fully coordinated, from bin to burners; the ball-bearing type pulverizer and rotating-table feeder being



B&W Integral-Furnace Boiler for an eastern central station — Capacity 150,000 lb. steam per hr. — Direct fired with high-volatile Kentucky bituminous coal.



Stirling Boiler in a mid-western municipal electric light plant — Capacity 125,000 lb. steam per hr. — Fired with high-volatile Indiana bituminous coal on a B&W Chain-Grate Stoker.

FUEL EMERGENCY-
Stoker Firing

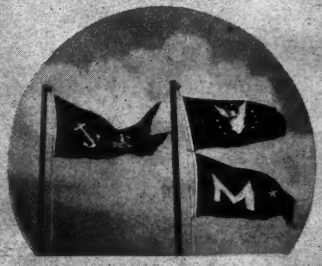
especially applicable to direct firing and to complete automatic control.

B&W Chain-Grate Stokers are widely used where economic considerations, size of boiler, and character of coal available make stoker firing advisable. These stokers burn a wide range of coals efficiently, are self-cleaning and low in maintenance.

B&W Water-Cooled Furnace Constructions have the diversity necessary for satisfying all the requirements of any method of firing, from supplying structural shape and strength, to promoting combustion and ash elimination in individual furnaces.

Complete B&W Boiler Units, such as those shown on these pages incorporating either method of firing and typical B&W Furnace Constructions, provide the means of meeting present-day fuel problems.

G-235T



The Maritime Victory flag and "M" burgee now float proudly alongside the Navy "E" at the Barberton Works. Each is an award for "outstanding achievement" and is "an honor not lightly bestowed".

BABCOCK & WILCOX

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET, NEW YORK, N.Y.

Enough man-days were lost through accidents last year to have produced 300,000 light tanks. To help minimize such losses, this Company has subscribed to the National Safety Council's War Production Fund to Conserve Man Power.

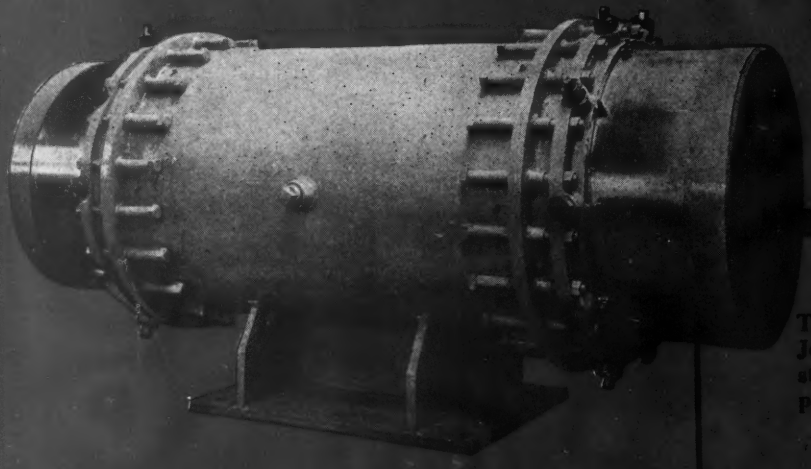
THERE'S

"IMPULSE"

The Yarway Impulse Steam Trap has only one moving part; no buckets, bellows, levers or floats. Bulletin T-1737.

"INVOLUTE"

The Yarway Involute Spray Nozzle is non-clogging, trouble-free. No internal parts; contour of body guides flow in an involute path. For cooling condenser water and for air conditioning service. Bulletin N-616.



"GUN-PAKT"

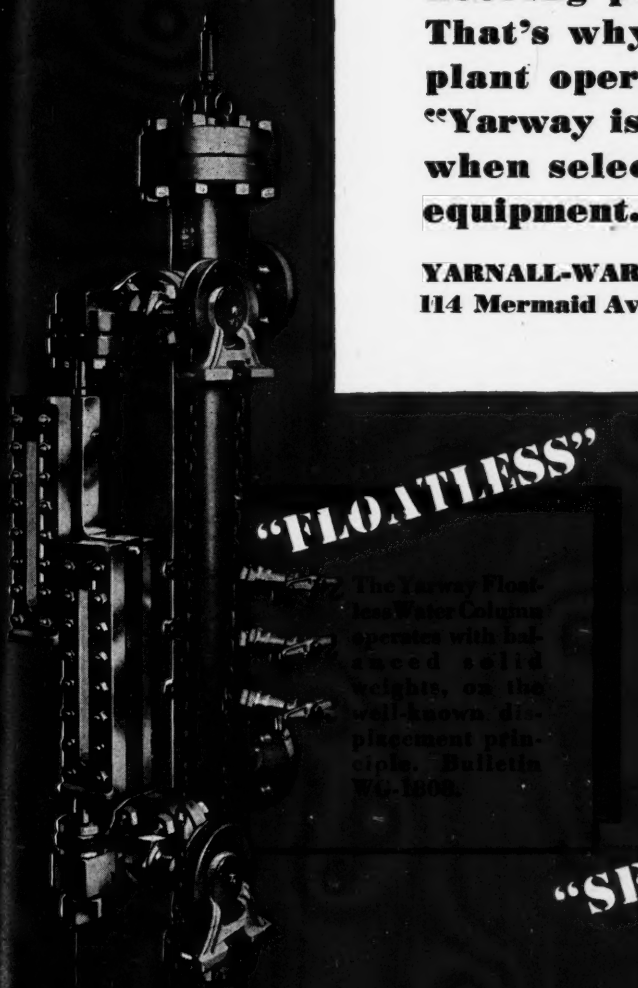
The Yarway Gun-Pakt Expansion Joint may be re-packed under full steam pressure and never needs more packing. Bulletin EJ-908.

YARWAY

A Reason..

ALL these Yarway Steam Specialties have become outstanding successes because of unique Yarway engineering principles. That's why so many plant operators say, "Yarway is our way" when selecting such equipment.

YARNALL-WARING COMPANY
114 Mermaid Ave. Phila.



"FLOATLESS"

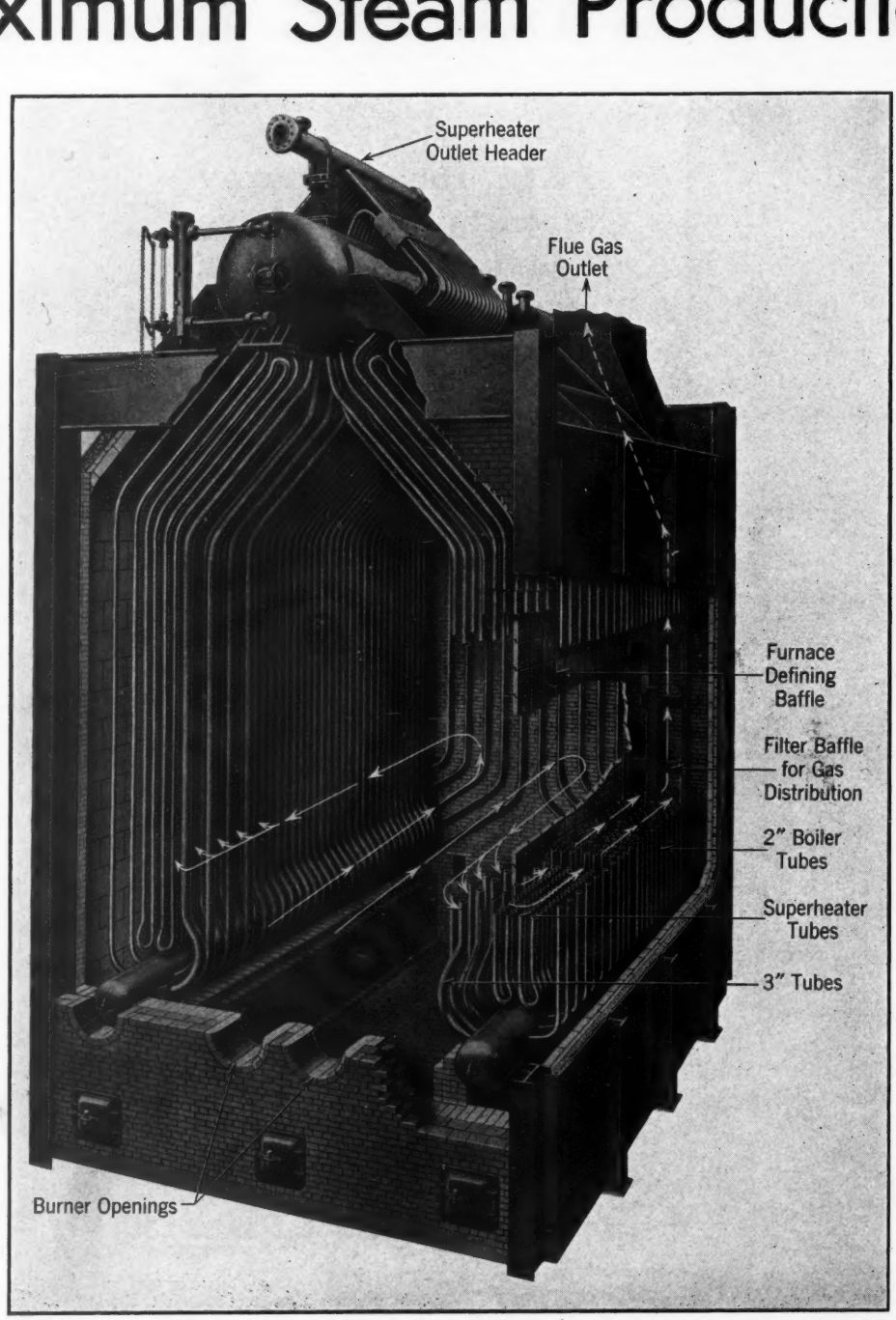
The Yarway Floatless Water Column operates with balanced solid weights, on the well-known displacement principle. Bulletin W6-1908.

"SEATLESS"

The Yarway Seatless Blow-Off Valve has no seat to score, wear and clog with mud, scale and dirt. Bulletin for high pressures B-431; for low pressures B-420.

STEAM SPECIALTIES

Maximum Steam Production



"S-A" BOILER

FW FOSTER

Per Ton of Boiler *Drum* Plate

—a WARTIME NECESSITY

MAXIMUM STEAM FROM MINIMUM MATERIALS IS IMPERATIVE IN NEW BOILERS.

The single drum, S-A boiler meets these war priority requirements. In addition it

1) Incorporates the advantages and performance of two drum, bent tube, water cooled furnace units.

2) Requires but one welded drum.

3) Effects great reduction in total drum plate requirements.

4) Doubles the number of boilers from one welding shop.

SINGLE DRUM "WAR" BOILERS OFFER MOST SPEEDY DELIVERY AND ARE IN GREATEST DEMAND

The Army-Navy Production "E" has been awarded to Foster Wheeler in recognition of quality equipment, in quantity, on time.

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK, N. Y.

WHEELER FW

PROOF that ARMSTRONG STEAM TRAPS Can Take it!

THIS picture shows how from 1/16th to 3/16th of an inch of hard scale was deposited on the inside of the body and cap as well as on the working parts of a No. 212 Armstrong Trap before cleaning was necessary. Note particularly the following:

1. Bright line on valve which shows that valve parts were still working.
2. Scale broken from bucket hook to indicate thickness of scale.
3. Scale around bucket vent but the vent was still open.

It takes an Armstrong free-floating lever trap to operate for long under such bad water conditions!

ARMSTRONG Traps won't do the impossible, but Armstrong's free-floating lever and quick-opening, tight-closing valve action have come through with flying colors on many a job that would have put an ordinary trap out of commission.

Ability of equipment to stay on the job with a minimum of maintenance takes on increasing importance every day. More reason why you should buy Armstrong Traps, install them properly and keep them in good repair. An Armstrong representative is ready to help you do this. Send for him today.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Michigan

MONTHLY MAINTENANCE TIP

You Can "Grind the Valves" in Armstrong Traps!

Armstrong Trap valve parts are so designed that they can be kept in service for an indefinite period without replacement by lapping valves and seats and by facing seats as illustrated at the right. Inspect your traps regularly. If the valves fail to seat properly, it will be worth your while to make repairs—a fast, simple job with Armstrongs. (Remember the Armstrong cap carries the works—disassembly is easy.)

Fig. 1: You can make several grindings on thickness "A" and still leave enough of the hex head to get a wrench hold.

FACING VALVE SEATS—See Fig. 1. Hold face of seat against flat side of grinding wheel or put in surface grinder. Relap after grinding.

LAPPING VALVE PARTS—See Fig. 2. Use breast drill and a fine lapping compound. No pressure—the weight of the drill is enough. Remove all traces of compound when finished.

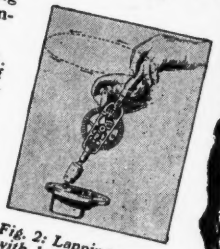
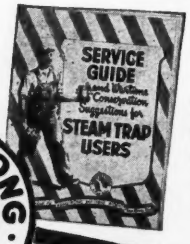
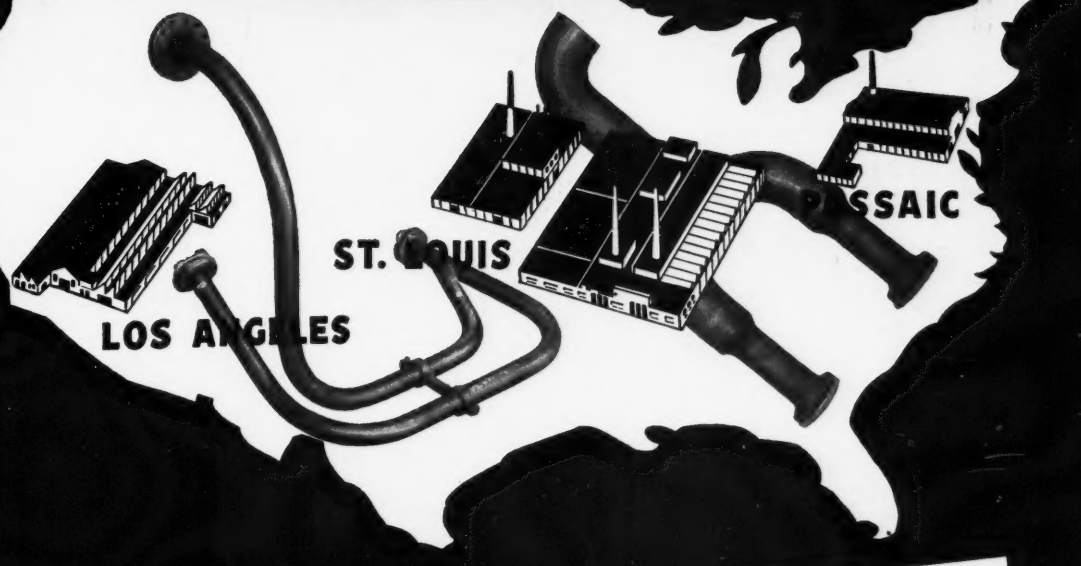


Fig. 2: Lapping valves with breast drill.



SEND FOR THIS BOOK
"Service Guide and Wartime Conservation Suggestions for Steam Trap Users". Your copy free on request.

MIDWEST PIPING SERVICE IS NATION-WIDE



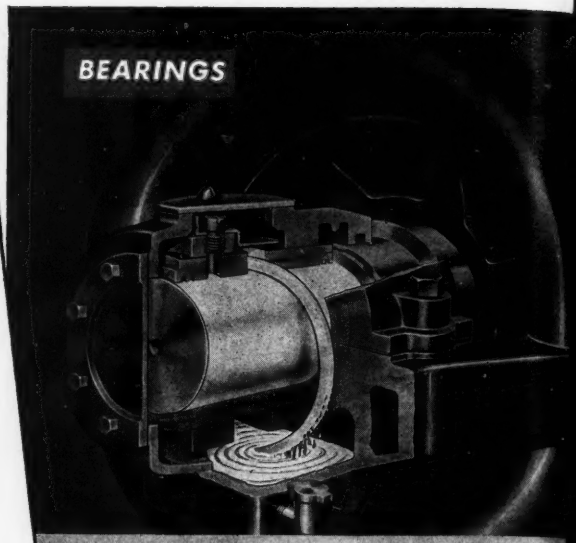
Now . . . that Time is more vital than ever before . . . the strategic locations of the Midwest plants for the fabrication of piping take on added importance. Each Midwest plant is a complete unit . . . provided with the most modern equipment and manned by a highly skilled organization for prefabricating all kinds of power plant and process piping. You will find it definitely advantageous to get in touch with the nearest Midwest office whenever you need fabricated piping . . . whether only a simple pipe bend, a coil or a complete alloy piping job.

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo. • Plants: St. Louis, Passaic (N. J.) and Los Angeles
Sales Offices: Chicago—949 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • San Francisco—436 Call Bldg. • Tulsa—533 Mayo Bldg.

WHILE YOU'RE WORRYING ABOUT PRODUCTION...

YOU AND YOUR MEN are working hard for production... driving to meet shipping dates. You know your machines are being "driven"—often by "green" help. Wouldn't you welcome aid in making sure *every* machine is properly taken care of with Correct Lubrication?



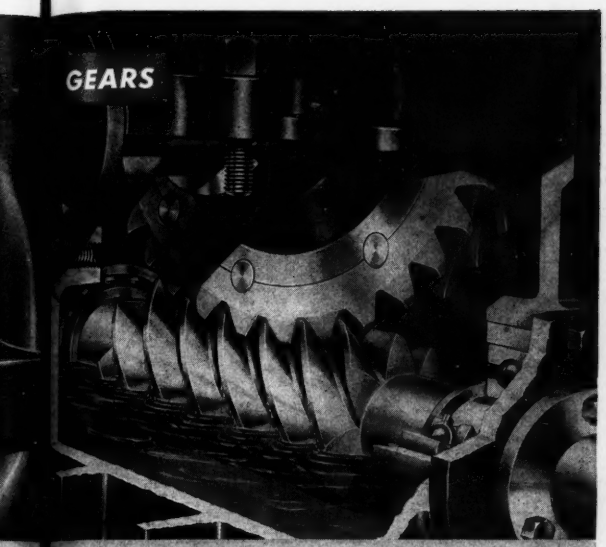
LOOKS SIMPLE—but size and type of bearing, speed, heat, load, method of application, all affect the choice of a lubricant. "Correct Lubrication" is a science! It demands skilled experience counsel.

Who's Looking Out f

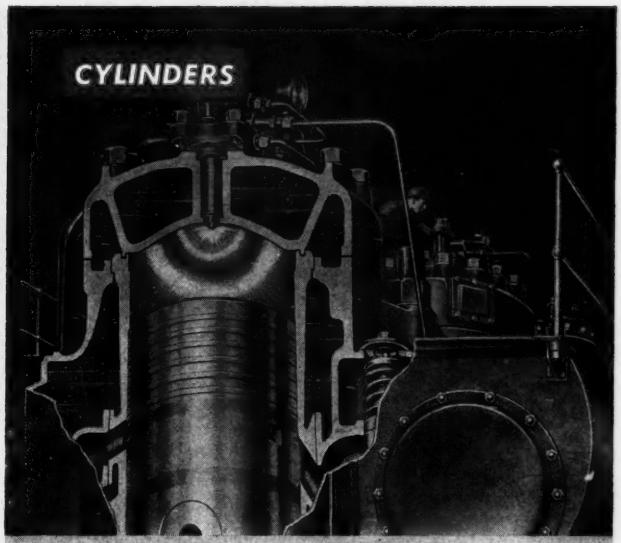
HERE'S A PLAN TAILOR-MADE FOR YOUR PLANT

THOSE TWO STEPS at the right bring you the sum of Socony-Vacuum's 76 years' experience, *the world's greatest*, in the lubrication field. Today, when there is no time for "second guesses" this knowledge is proving its value in helping industry do its biggest job!

1 LUBRICATION PLANNING—After careful study of your machines and their operating conditions, your Socony-Vacuum man will work out a guide of lubrication recommendations with your own engineers.



IRREPLACEABLE—Precision-made gears, in fact all production equipment, should be viewed as irreplaceable. This places an added burden on lubrication . . . emphasizes need for only the best!



DEPENDABLE POWER—The hum of your power plant is the heartbeat of your production line. Diesels, turbines, steam engines exist on "Correct Lubrication" as prescribed by a lubrication engineer.

for Your Machines?

LUBRICATION CONTROL—By means of this lubrication program . . . through the help of the Socony-Vacuum man . . . you will be freer to drive for more production. He will gladly help look out for your machines!

TO HELP MAINTAIN WARTIME PRODUCTION CALL IN

SOCONY-VACUUM

FOR *Correct Lubrication*

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC. • Standard Oil of N.Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Southeastern Div. (Baltimore) • Magnolia Petroleum Co. • General Petroleum Corp. of Calif.

DETROIT EDISON P
THE ARSENAL

Electric power will pave the way to Victory!

As the giant industries of America gain momentum, surging ahead faster and faster in the race against the forces of tyranny, the public utilities of America are put to the test. The electric power must be there before America's producers can hit the Victory pace!

The Detroit Edison Company, source of power for the Greater Detroit area, is an outstanding example of American public utilities on the march . . . producing dependable electric power in the constantly increasing amounts required by the gigantic Arsenal of Democracy it serves.

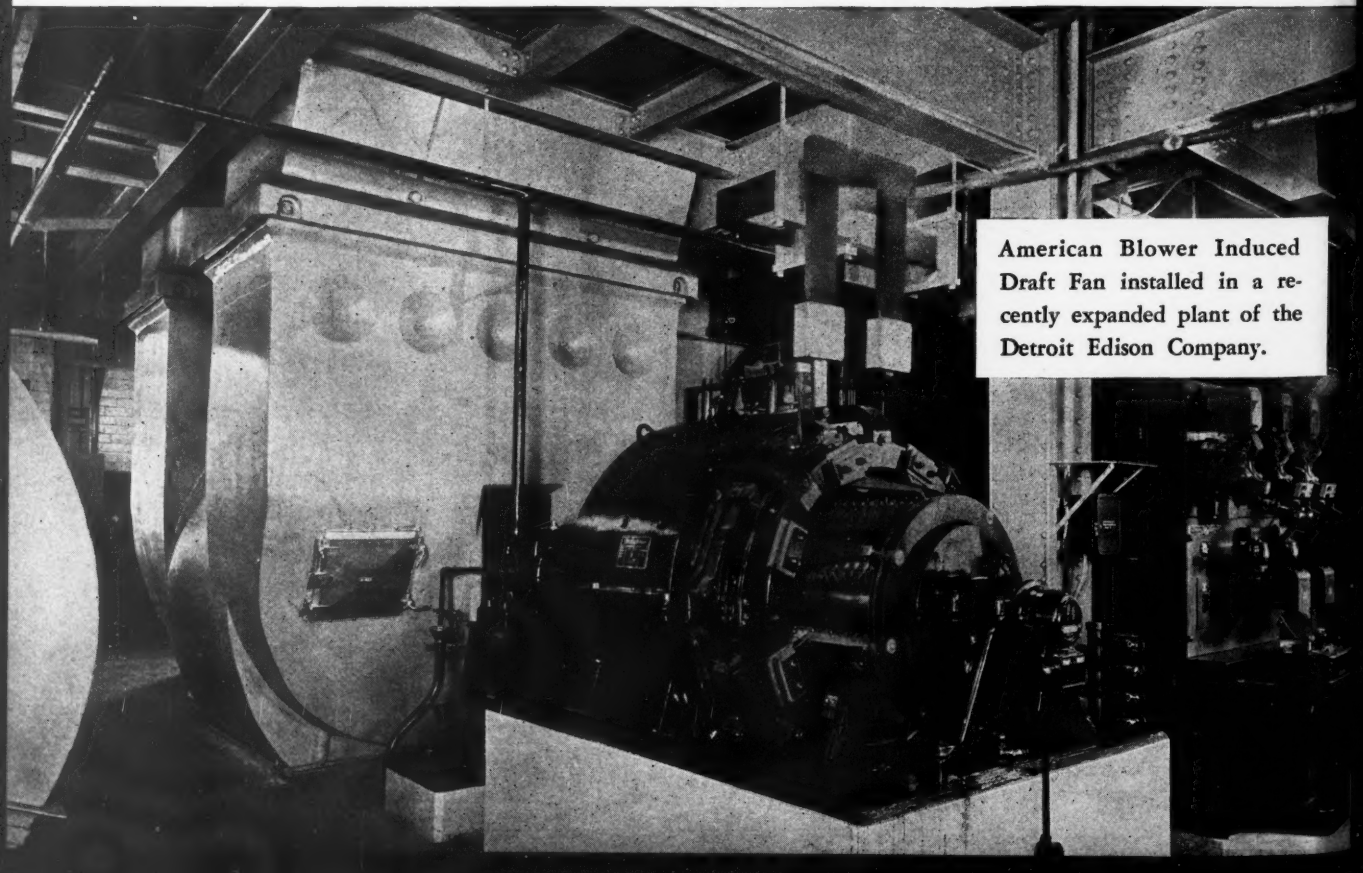
Expansion of the company's generating resources to serve newly expanded war industries demonstrates the flexibility and perfect coordination of the far-flung Detroit Edison system.

American Blower Forced and Induced Draft Fans are being used extensively in the company's war expansion program. We of American Blower are proud of the part we have played and are playing in furnishing this and other vital power plant equipment to the Detroit Edison Company.

AMERICAN BLOWER

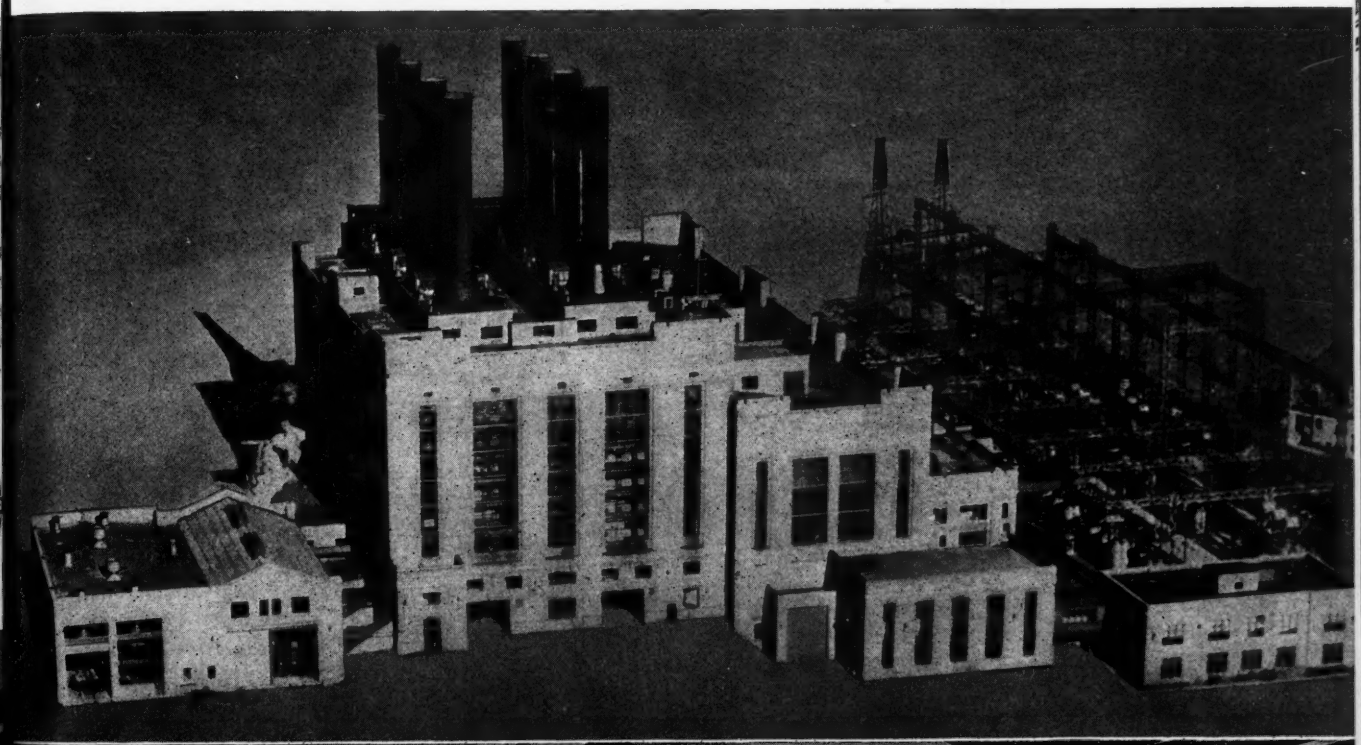
AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN • In Canada: CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

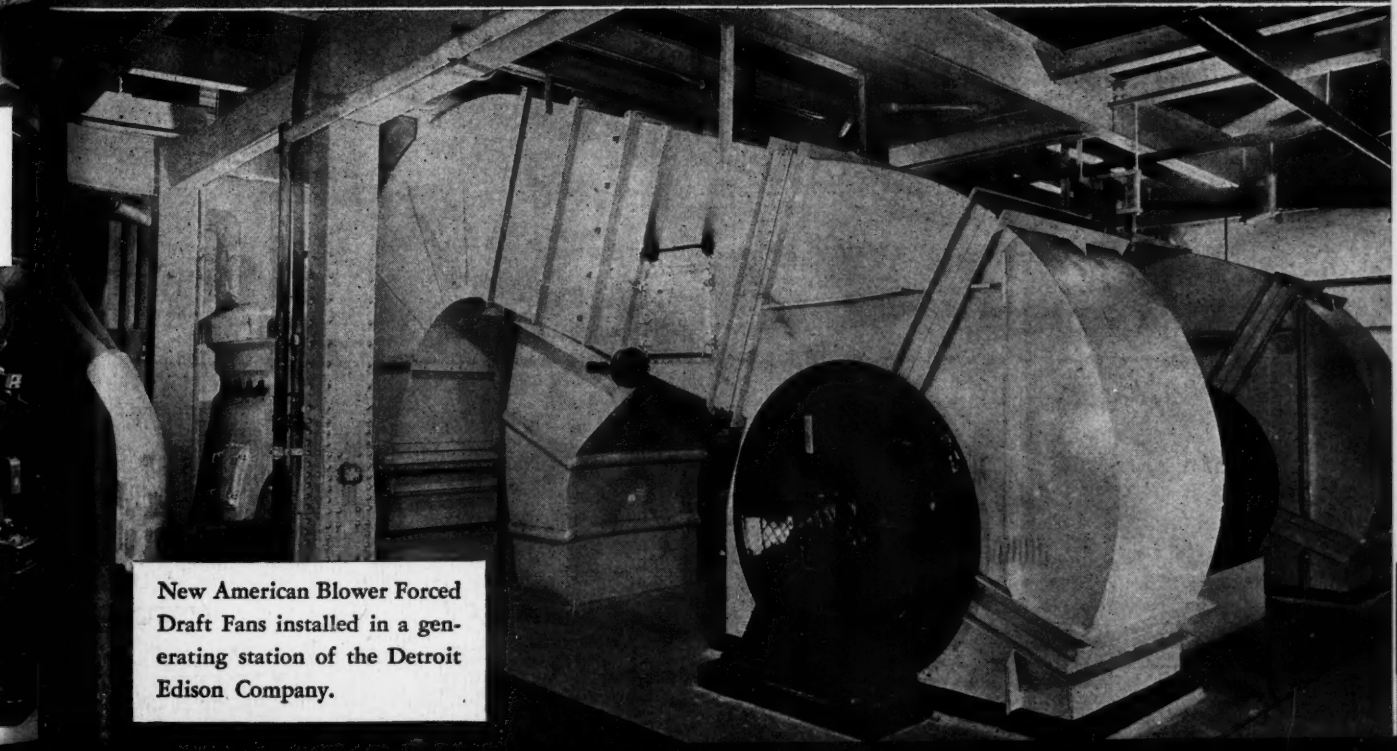
Division of AMERICAN Radiator and Standard Sanitary Corporation



American Blower Induced Draft Fan installed in a recently expanded plant of the Detroit Edison Company.

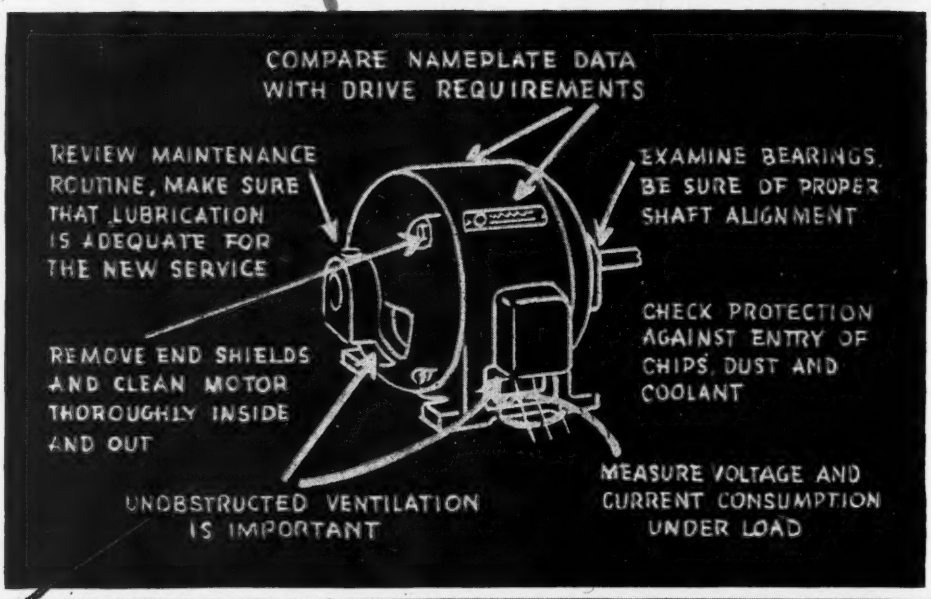
POWER FOR
OF DEMOCRACY

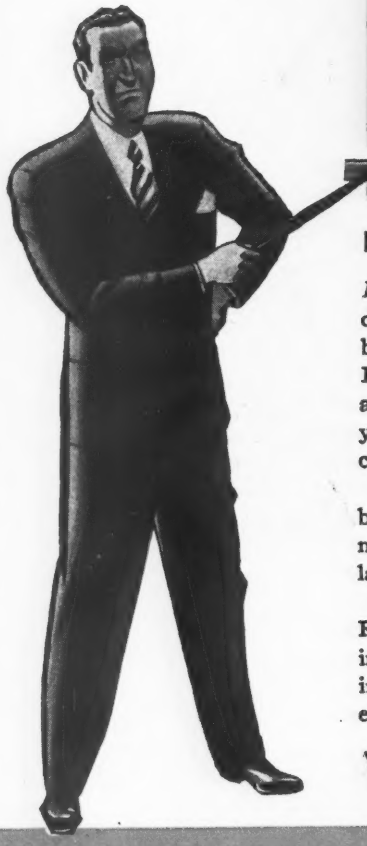




New American Blower Forced Draft Fans installed in a generating station of the Detroit Edison Company.

IT'S TIME TO BE A CRANK ABOUT MOTOR CARE


COMPARE NAMEPLATE DATA WITH DRIVE REQUIREMENTS
REVIEW MAINTENANCE ROUTINE, MAKE SURE THAT LUBRICATION IS ADEQUATE FOR THE NEW SERVICE
EXAMINE BEARINGS. BE SURE OF PROPER SHAFT ALIGNMENT
CHECK PROTECTION AGAINST ENTRY OF CHIPS, DUST AND COOLANT
REMOVE END SHIELDS AND CLEAN MOTOR THOROUGHLY INSIDE AND OUT
MEASURE VOLTAGE AND CURRENT CONSUMPTION UNDER LOAD
UNOBSTRUCTED VENTILATION IS IMPORTANT



protect your production with this maintenance plan

Planned motor maintenance, keyed to today's loads and conditions, saves vital hours by forestalling future breakdowns and delay. In replacing hit-or-miss motor servicing with a regular schedule of trouble-*prevention*, you'll find real help in the new G-E publication, "How to Care for Motors."

The check list (right) tells what to do. This book tells how to do it, using well-proved methods that save time and help assure long-lasting motor service.

And, of course, your local G-E Motor Representative is always ready to aid you in putting these suggestions into practice, or in getting the new motors you may need for essential wartime projects.

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in six plants manufacturing naval equipment.

1 Make sure that motors are selected to ***match the job.*** Install motors so they are properly aligned with the driven load and are easily accessible for regular inspection.

See "How to Care for Motors"

2 Keep motors free from dust and dirt. Establish a definite cleaning schedule.

See "How to Care for Motors"

3 Be sure that lubrication is frequent enough to take care of increased production. See that employees are instructed as to proper methods.

See "How to Care for Motors"

4 A general overhauling of hard-worked motors will add years to their life. If your motors haven't had an overhaul in the last year, try to arrange your schedule to permit one.

See "How to Care for Motors"

General Electric, Sec. D750-179
Schenectady, N. Y.

Yes, send me a copy of "How to Care for Motors," GEA-2856A.

Name.....

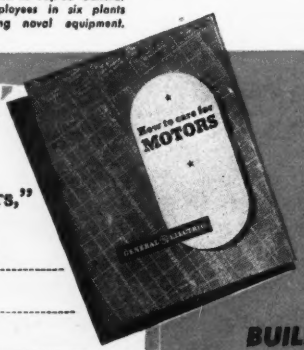
Title.....

Company.....

Address.....

City.....State.....

8090



HOW TO CARE FOR MOTORS

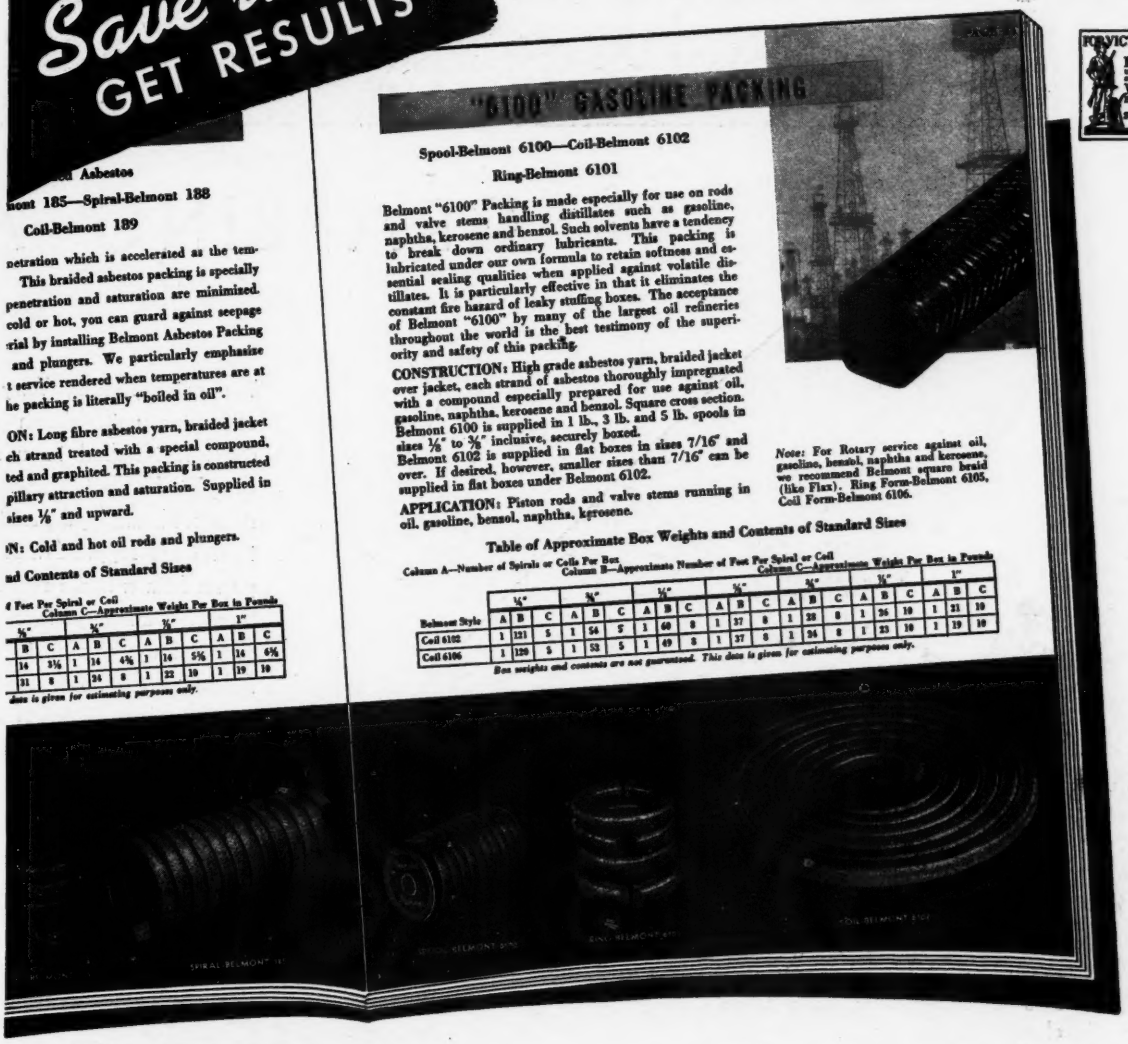
Every supervisor and maintenance man will find this book of value . . . it tells what to do to get the most out of motors, old or new. If you're setting up a maintenance program to keep up with today's unprecedented demands, or if you're "switching" motors from one job to another, or equipping machines with new motors, you'll find this booklet of helpful motor facts will save you time. Write for a copy.

BUILDER OF TRI-CLAD MOTORS

GENERAL ELECTRIC

Use the Belmont Packing Catalog to Solve Your Packing Problems

Save time.. GET RESULTS



...Asbestos

...mont 185—Spiral-Belmont 188

Coil-Belmont 189

...netration which is accelerated as the tem-

This braided asbestos packing is specially ... penetration and saturation are minimized. ... cold or hot, you can guard against seepage ...rial by installing Belmont Asbestos Packing ... and plungers. We particularly emphasize ...t service rendered when temperatures are at ...he packing is literally "boiled in oil".

...ON: Long fibre asbestos yarn, braided jacket ...ch strand treated with a special compound, ...ted and graphited. This packing is constructed ...pillary attraction and saturation. Supplied in ...sizes 1/8" and upward.

...N: Cold and hot oil rods and plungers.

...nd Contents of Standard Sizes

...t Per Spiral or Coil
Column C—Approximate Weight Per Box in Pounds

¼"			⅜"			½"			1"		
B	C	A	B	C	A	B	C	A	B	C
14	3⅛	1	14	4⅝	1	14	5⅝	1	14	6⅝
31	8	1	24	8	1	22	10	1	19	10

...data is given for estimating purposes only.

"6100" GASOLINE PACKING

Spool-Belmont 6100—Coil-Belmont 6102

Ring-Belmont 6101

Belmont "6100" Packing is made especially for use on rods and valve stems handling distillates such as gasoline, naphtha, kerosene and benzol. Such solvents have a tendency to break down ordinary lubricants. This packing is lubricated under our own formula to retain softness and essential sealing qualities when applied against volatile distillates. It is particularly effective in that it eliminates the constant fire hazard of leaky stuffing boxes. The acceptance of Belmont "6100" by many of the largest oil refineries throughout the world is the best testimony of the superiority and safety of this packing.

CONSTRUCTION: High grade asbestos yarn, braided jacket over jacket, each strand of asbestos thoroughly impregnated with a compound especially prepared for use against oil, gasoline, naphtha, kerosene and benzol. Square cross section. Belmont 6100 is supplied in 1 lb., 3 lb. and 5 lb. spools in sizes ⅛" to ⅞" inclusive, securely boxed. Belmont 6102 is supplied in flat boxes in sizes 7/16" and over. If desired, however, smaller sizes than 7/16" can be supplied in flat boxes under Belmont 6102.

APPLICATION: Piston rods and valve stems running in oil, gasoline, benzol, naphtha, kerosene.

Note: For Rotary service against oil, gasoline, benzol, naphtha and kerosene, we recommend Belmont square braid (like Flax). Ring Form-Belmont 6105, Coil Form-Belmont 6106.

Table of Approximate Box Weights and Contents of Standard Sizes

Column A—Number of Spirals or Coils Per Box
Column B—Approximate Number of Feet Per Spiral or Coil
Column C—Approximate Weight Per Box in Pounds

Belmont Style	¼"			⅜"			½"			⅝"			¾"			⅞"			1"		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Coil 6102	1	121	5	1	54	5	1	60	8	1	37	8	1	25	8	1	26	10	1	21	10
Coil 6106	1	120	5	1	52	5	1	49	8	1	37	8	1	24	8	1	23	10	1	19	10

Box weights and contents are not guaranteed. This data is given for estimating purposes only.

NOT JUST ANOTHER CATALOG—but a packing reference book prepared by packing manufacturers. 84 pages of packing information, all reduced to its simplest form; with each and every type of Belmont packing clearly illustrated and described—as shown in the facsimile page above.

The Belmont Packing Catalog includes recommendation charts that enable you to check instantly, by type of service, Belmont's choice of packing styles (listed in the order of our selection). Packing end views are pictured in large size showing minute details. Construction, applications, tables of weights and measures are all laid out in easily readable form so that everything can be taken in at a glance.

The Belmont Packing Catalog is a time-saver, a book you should not be without. Write on your Company letterhead for your copy today.

There's a Belmont Packing for every service: Steam, Water, Oil, Gas, Air, Acid, Alkalies, Ammonia. Forms include: Rings, Coils, Spirals, Reels, Spools, Sheets, Gaskets.

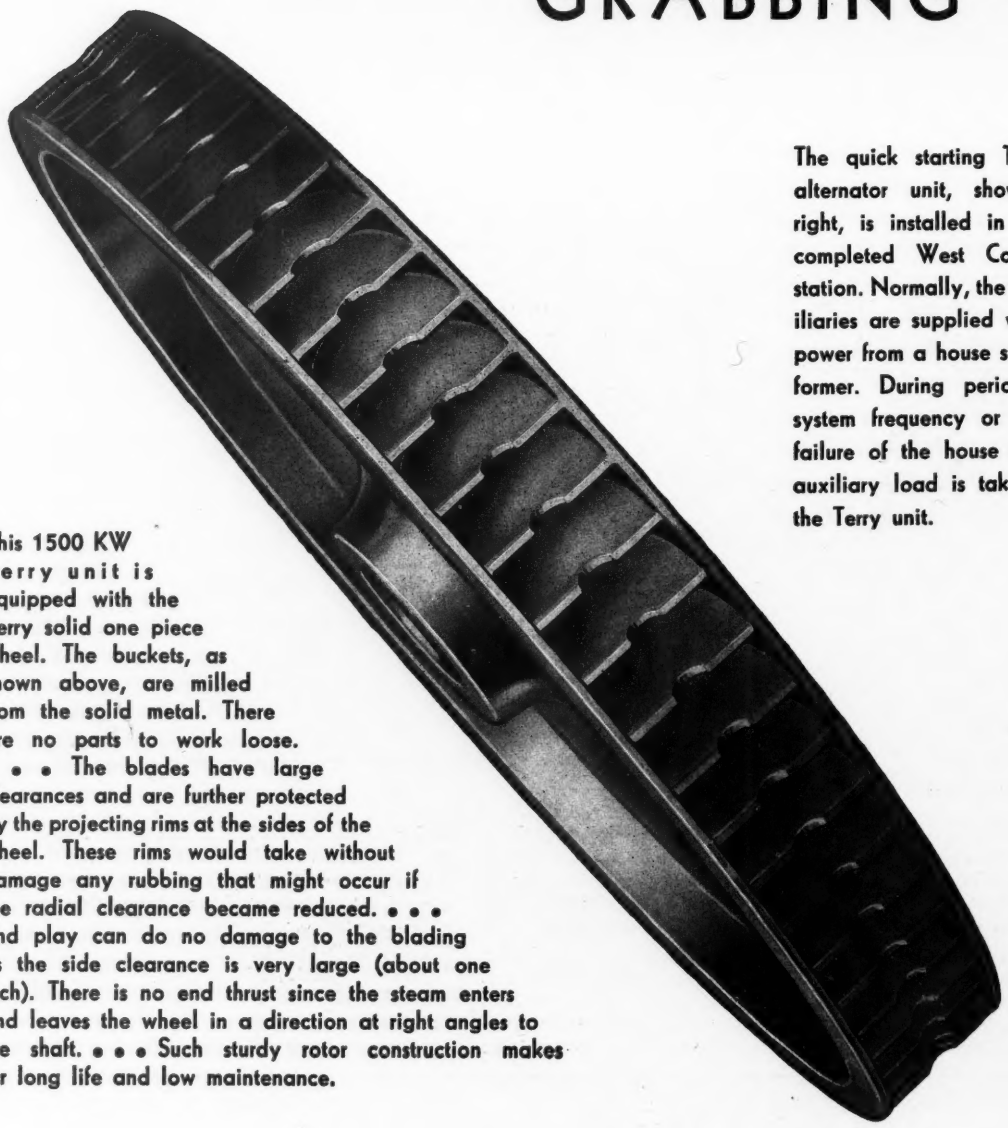
Belmont Packings are Sold by Authorized Belmont Distributors in Every Large Industrial Center

BELMONT PACKINGS

THE BELMONT PACKING & RUBBER COMPANY
Butler and Sepviva Streets Philadelphia, Pa.

The TERRY

GRABBING A



This 1500 KW Terry unit is equipped with the Terry solid one piece wheel. The buckets, as shown above, are milled from the solid metal. There are no parts to work loose. • • • The blades have large clearances and are further protected by the projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced. • • • End play can do no damage to the blading as the side clearance is very large (about one inch). There is no end thrust since the steam enters and leaves the wheel in a direction at right angles to the shaft. • • • Such sturdy rotor construction makes for long life and low maintenance.

The quick starting Terry turbo-alternator unit, shown at the right, is installed in a recently completed West Coast central station. Normally, the station auxiliaries are supplied with electric power from a house service transformer. During periods of low system frequency or in case of failure of the house service, the auxiliary load is taken over by the Terry unit.

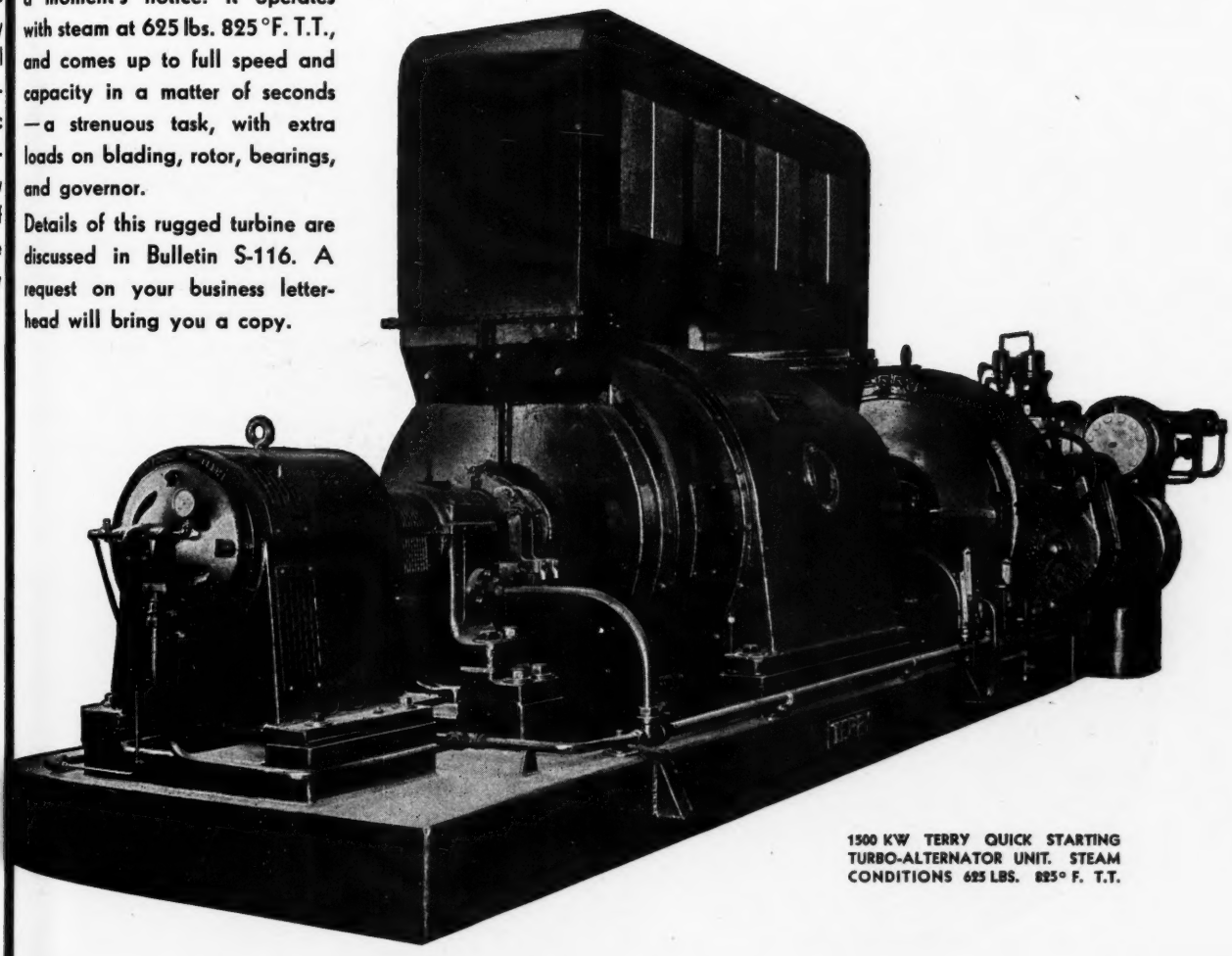
THE TERRY STEAM TURBINE CO.

Wheel Turbine

1500 KW LOAD ON A MOMENT'S NOTICE!

The unit is ready to take over on a moment's notice. It operates with steam at 625 lbs. 825 °F. T.T., and comes up to full speed and capacity in a matter of seconds —a strenuous task, with extra loads on blading, rotor, bearings, and governor.

Details of this rugged turbine are discussed in Bulletin S-116. A request on your business letterhead will bring you a copy.



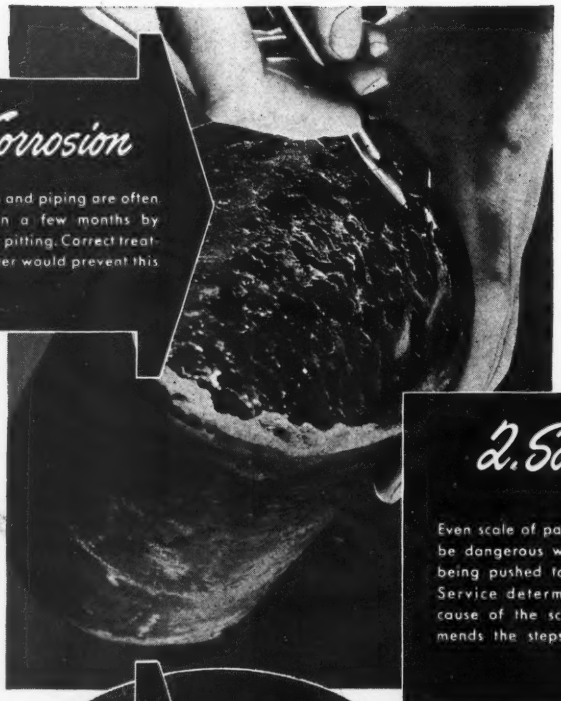
1500 KW TERRY QUICK STARTING TURBO-ALTERNATOR UNIT. STEAM CONDITIONS 625 LBS. 825° F. T.T.

T-1150

TERRY SQUARE - HARTFORD, CONN.

These enemies of your

But you can



1. Corrosion

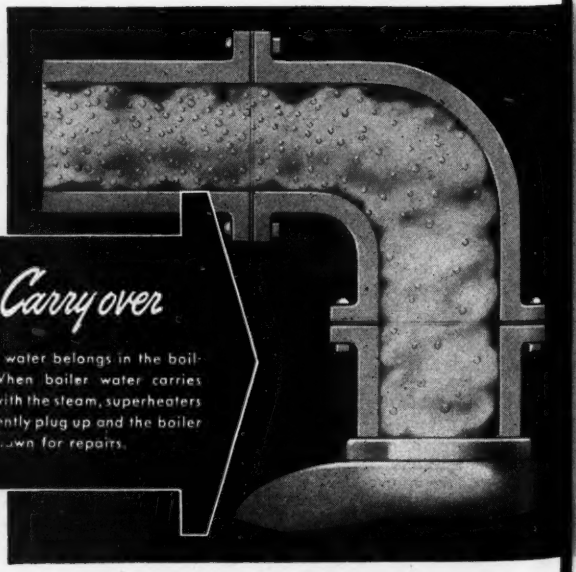
Boiler tubes and piping are often destroyed in a few months by corrosion or pitting. Correct treatment of water would prevent this sabotage.

2. Scale

Even scale of paper thinness can be dangerous when boilers are being pushed to the limit. Hall Service determines the basic cause of the scale and recommends the steps for correction.

3. Embrittlement

Tough steel fails like brittle glass when improperly treated boiler water allows caustic embrittlement to start. No sabotage could be worse than this.



4. Carry over

Boiler water belongs in the boiler. When boiler water carries over with the steam, superheaters frequently plug up and the boiler goes down for repairs.

steam production are tough!

lick them... just as hundreds of other war industries have, if you take the right step...and in time!

LIKE the germs in the human body which are always ready to start their deadly work at the first sign of physical weakness, Scale—Corrosion—Carryover and Embrittlement are ready to cripple your boiler system the moment you let up on your vigilance. You can't get away from their ever-present menace but you *can* protect your plant from them.

How? Through scientifically applied "preventive care" supplied by competent specialists whose life work and training is for the sole purpose of *keeping these boiler enemies under control.* There is no satisfactory substitute for such help. Its need began with the first pressure boiler. It became more acute as pressures increased. Today, it is a necessary requirement of the modern plant.

Hall research was founded to meet this need.

We met it by putting chemists and engineers on the problem who held to their research until they established the basic fundamentals of boiler water conditioning now universally accepted and employed. Your own operations are influenced by this work. Every modern power plant has profited through it.

Perhaps you already knew that. The story of Hall research and subsequent development is common knowledge among power plant technicians. But did you know that it is the very men who did that job who would supervise the servicing of your boilers—that they *are* the Hall operating staff and it is in their laboratories the field engineers are trained who would work on your problems?

Think of this difference. Investigate it. Weigh it against what you have seen of such services. We will be glad to put all the facts before you.

HALL LABORATORIES, INC.
HAGAN BUILDING • PITTSBURGH, PA.

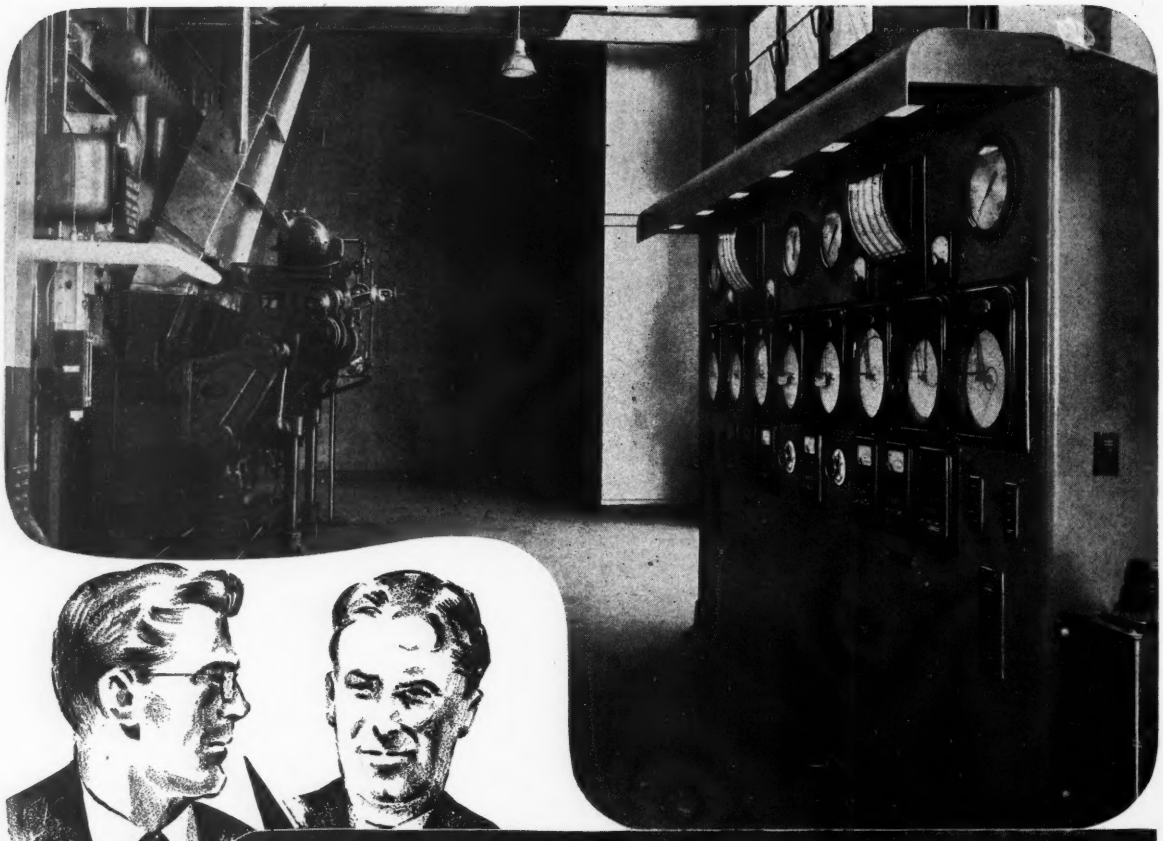
HALL SERVICE IN A NUTSHELL

At your immediate disposal are placed the technical knowledge and facilities of the pioneering leaders in scientific boiler water conditioning.

In addition, with your full cooperation Hall Service:

1. Minimizes boiler outages caused by water.
2. Helps maintain highest efficiency.
3. Establishes non-embrittling water.
4. Minimizes carryover.
5. Prevents corrosion in boilers and associated equipment.
6. Prevents deposition in water lines and cooling systems.

HALL SYSTEM *of Boiler Water Conditioning*



"WE SELECTED HAYS CONTROL BECAUSE IT IS EASIER FOR OUR OPERATORS TO UNDERSTAND"

...*So said* THE CHIEF ENGINEER of the above boiler room located in a mid-west municipal light plant. He went on to explain to two engineers* who were investigating several combustion control systems—

"Our men lived with Hays Automatic Combustion Control in our old plant for several years and they liked its simplicity, and its positive operation. Because it was easier to understand than the other systems on the market they took a keener interest in it and produced better results."

"Before selecting boiler control for our new high pressure plant I made trips to several near by cities inspecting the most recent installations of all types of control systems. These trips served to confirm my original opinion of Hays, so we selected Hays for our new plant also."

*The result of this interview was the sale of complete Hays Automatic Combustion Control for 7 boilers in a large automotive product plant.

HAYS *automatic*
COMBUSTION CONTROL

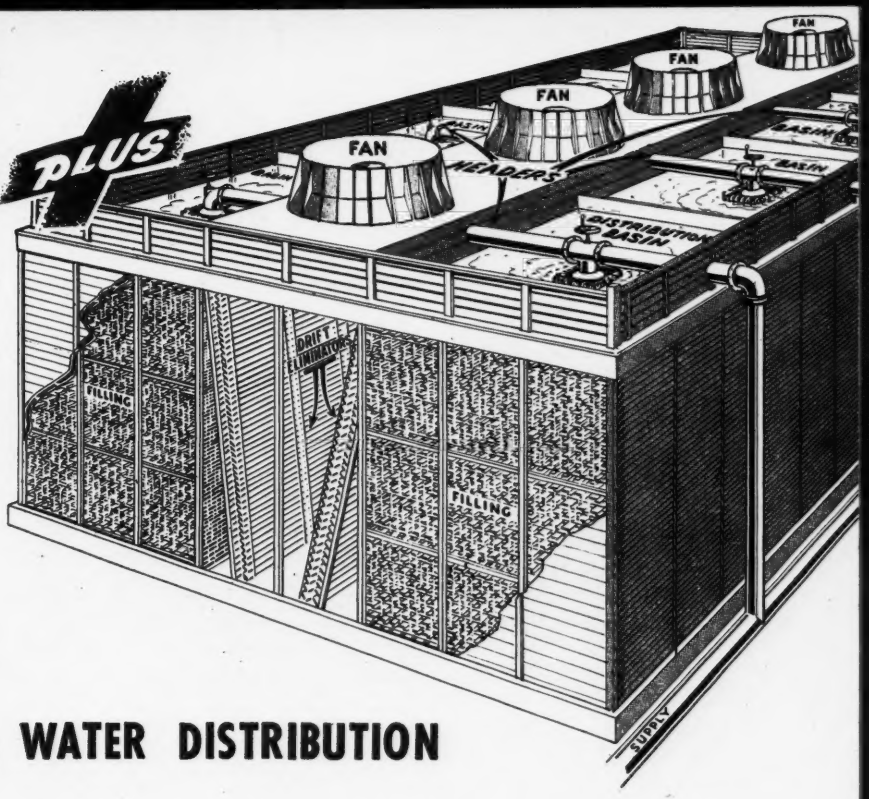
is being preferred more and more over other control systems for very definite reasons. In the first place it is completely electric, which simplifies design, installation and operation.

It is the only system that has all instruments and controllers centralized on a single panel and not scattered all over the boiler room or hung on the side of the boiler. Adjustments are direct and not dependent on air pressures, oil pressures, and the complicated valve mechanisms made necessary by most other designs.

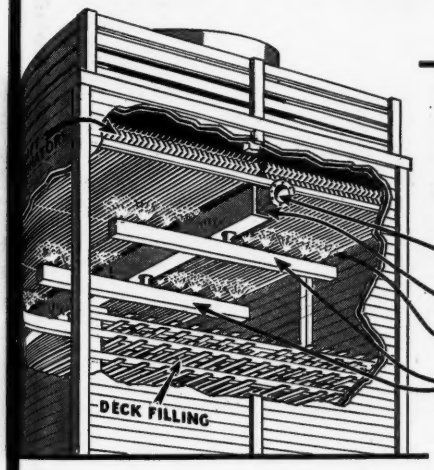
You will want to learn more about this thoroughly modern system that is maintaining boiler room efficiency and lowering operating costs in hundreds of plants. Send for 40-page catalog 41-304 today.

The HAYS CORPORATION
SINCE 1907 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

Another of MARLEY'S Features



Complete and Uniform WATER DISTRIBUTION



—In MARLEY "STANDARD" Induced Draft Cooling Towers

Flanged Inlet CONNECTION

Open Flume HEADER

UP-SPRAY NOZZLES

DISTRIBUTION LATERALS Spaced for Uniform Coverage

Fullest efficiency in a cooling tower calls for *uniform* distribution of water over the entire fill area — no "dead spots". In Marley "Standard" towers this is accomplished by a unique system that achieves the results of high-pressure spray distribution *without* its extra pumping cost. Only sufficient pressure is required to raise water into the Header Flume from whence gravity pressure fills the Distribution Laterals completely and forces the water out through *up-spraying* nozzles. Thus, discharge from all nozzles is everywhere perfectly equalized, water is exposed to the passing air throughout a longer fall, and still finer break-up is provided as it splashes, evenly spread, over the top deck of the tower filling.

—In MARLEY "DOUBLE-FLOW" Induced Draft Cooling Towers

Water distribution in the Marley "Double-Flow" presents advantages as usual as the patented design of the tower itself. It is the only cooling tower having the primary distribution system *entirely external*, with all parts open to view and easy to reach while in operation.

Also *full, even* distribution is maintained from as little as 10% of normal capacity up to 200%, with no change in the distribution system or in the tower's efficiency.

The all-over uniformity of pressure distribution is combined with the economy of gravity-feed by utilizing the tower's roof to provide broad, shallow distribution basins, one on each side of each fan. Only slight pressure is needed to equalize water volume in all basins and from there distribution is by gravity alone. This is a major reason why the "Double-Flow" tower's pumping requirements are so extremely low—only 20 feet in most cases, or just enough to lift water to the top of the low tower.

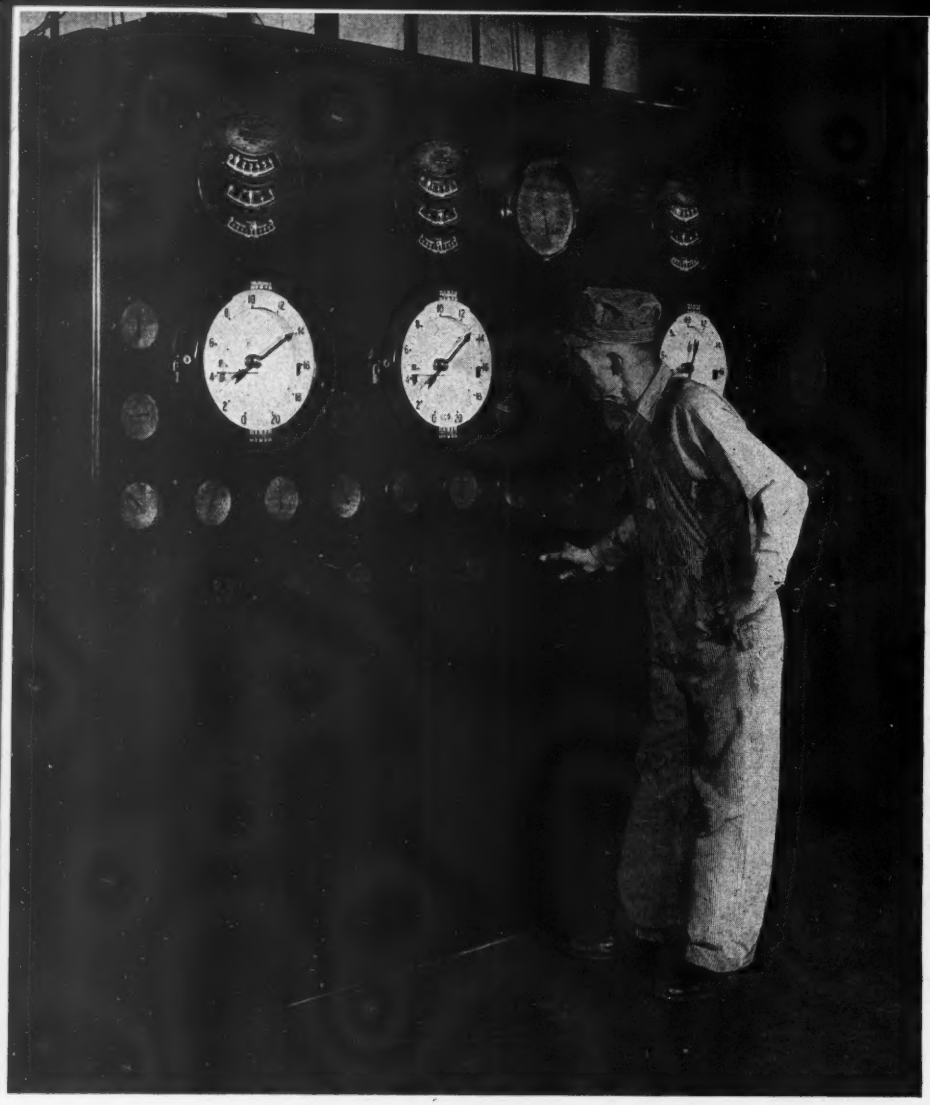
From the supply risers, water is conveyed either by pipes or flumes to the basins, each equipped with an individual control valve for regulating volume. The water spreads out to a depth of several inches in each basin and falls with equalized force through a regular pattern of orifices in the basin floor. The top deck of filling inside the tower is specially designed to obtain an even spread and a thorough break-up of the water.

Effective water distribution at minimum pumping cost is just one more of the outstanding features which, added together, explain why among all cooling towers Marley is the name most frequently seen.

This is one of a series of advertisements, each devoted to a Marley cooling tower feature which has become an accepted standard of best practice.

MARLEY 8-42-A COOLING TOWERS

Every MARLEY TOWER *is individually engineered by* THE MARLEY CO., INC. — KANSAS CITY, KANSAS



HOW SCIOTO MEN Found the Answer to a CO_2 Recording Problem

Here's a success story from Scioto Station of Marion Reserve Power Co., Marion, Ohio:

For years, executives and boiler operators alike had wanted automatic records of CO_2; and for years they had been disappointed. They tried every device that came their way, but success was not for them; after each trial, back they went to their hand Orsats. Apparently, if an automatic CO_2 instrument was sensitive it was also easily corroded; if it was durable it had an unbearable time-lag; if it was good in every other way, it required half a man's time to keep it serviced. In station after station, everywhere they'd worked, engineers and operators had had the same experiences.

So, when the Micromax CO_2 Recorder came along, those gentlemen did no rushing in to try it. But they did read about it, and listen to descriptions. Such facts as "revolutionary change in principle; no drying line; no dessicators because gas is saturated; no cell corrosion; as fast as a Micromax pyrometer" caught their attention. And, because they wanted sincerely to succeed in improving their operation in ways which a good CO_2 Recorder could help, they finally installed just one round-chart Micromax CO_2 Recorder.

After months of Orsat checks; after operating first with the Recorder and then without; after watching it in every conceivable way, they found themselves using CO_2 readings as freely and as confidently as they used their draft gauges, pressure gauges, flowmeters and pyrometers. They had licked the CO_2 bogey. The fact that their station happens to require (and now has) three CO_2 Recorders, verifies their success.

If any reader has a CO_2-recording problem, we'll be glad to hear of it, and to send Catalog N-91-163, which describes Micromax CO_2 Recorders.

Admiral Henry A. Wiley, with Factory Manager W. R. Coley of L&N, pauses for a word with an L&N girl employee at time of Army-Navy "E" Award to L&N.

"E" for L&N

The Army-Navy E was awarded to the Leeds & Northrup Co. on September 5, in ceremonies featured by the presentation of the "E" Burgee to the organization as a whole, and the authorization of "E" Pins to its members.

Admiral Henry A. Wiley praised the Company's attitude, and the results it has produced. President C. S. Redding of L&N, joined by spokesmen for L&N employee groups, pledged continued increases in production. The Company's output consists of classified materiel, in addition to its established lines of instruments, telemeters, automatic controls and heat-treating furnaces.

William L. Batt, Vice-Chairman of W.P.B., voiced the Board's pleasure at having the achievements of Industry so recognized by our armed forces.

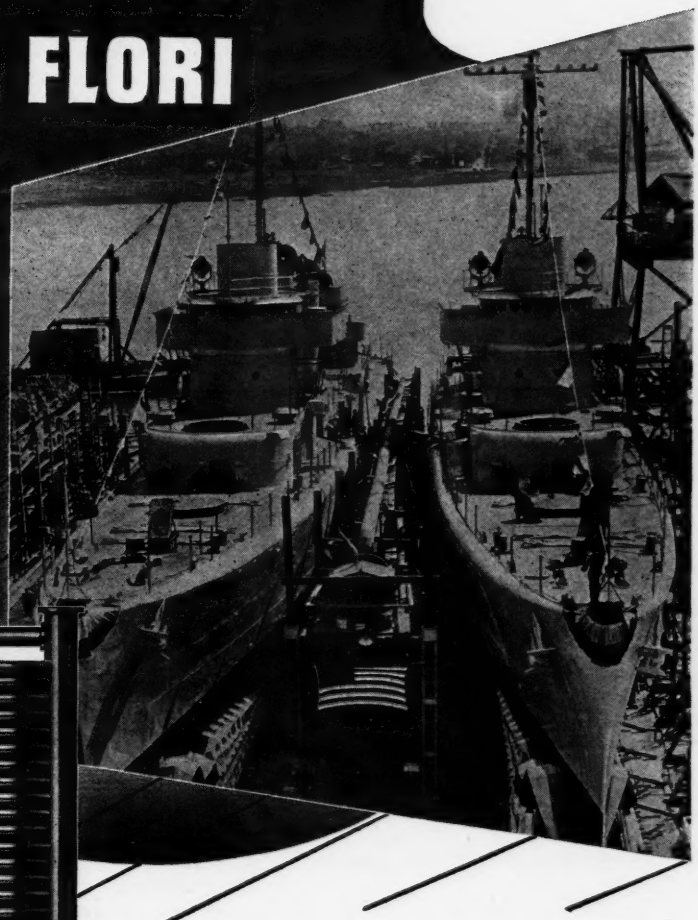
Jrl Ad N-91-163(11)

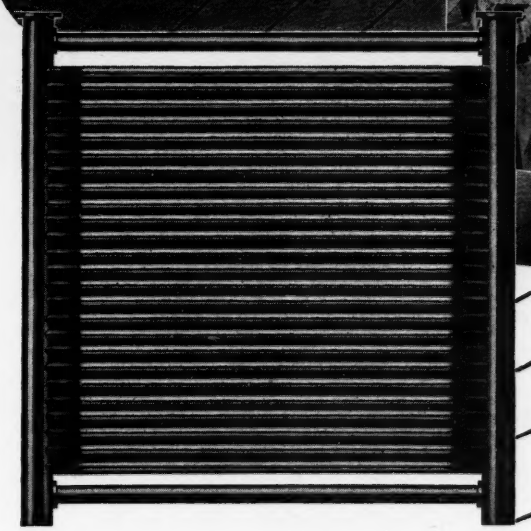
LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

IF IT'S PIPING CONTACT FLORI





OUR scope: Fabricated Piping...for steam, water, air, oil, gas, chemicals

Random mill or cut lengths, bent, coiled, welded, flanged, threaded. Valves, Pipe Fittings.

In brief: anything in tubular or plate steel fabrication.

Our customers: United States of America and Allied Nations.

Send us your inquiries.

FLORI PIPING

OFFICIAL U S. NAVY PHOTOGRAPH

THE FLORI PIPE COMPANY • ST. LOUIS, MO.

FEED WATER HEATERS . . . In All Pressure Ranges Employed in Modern Power Plant Design

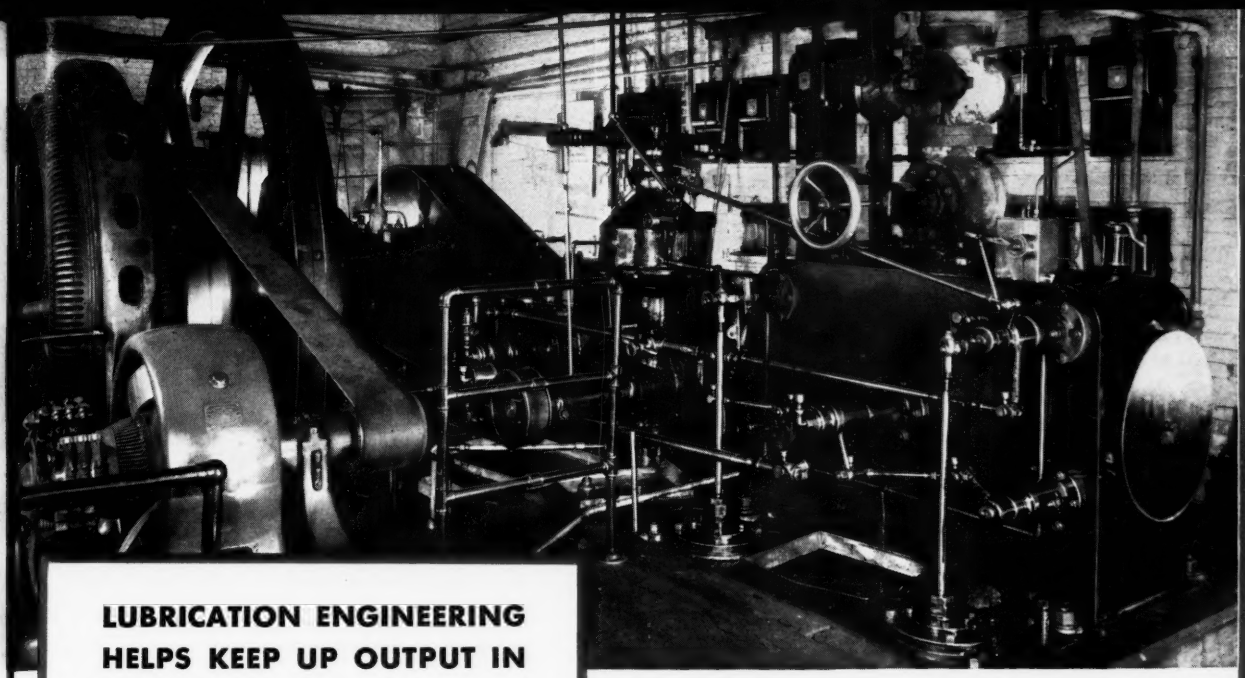
In numerous power plants, feed water heaters of Lummus design and construction are operating at pressures up to 1200 pounds. Lummus heat exchangers of the same type of construction are operating at pressures up to 2200 pounds.

In addition to feed water heaters of improved design, Lummus offers public utility and power plants, surface condensers, evaporators, ejectors and similar equipment to meet specific conditions. Write for further information.

THE LUMMUS COMPANY · 420 LEXINGTON AVE., NEW YORK, N.Y.

LUMMUS

FEED WATER HEATERS



LUBRICATION ENGINEERING HELPS KEEP UP OUTPUT IN THESE TYPICAL PLANTS

PROBLEM—Excessive valve wear developed on the Corliss engine pictured above in a Wisconsin manufacturing plant. The engine would not pull its normal load—steam consumption was so high it was necessary to shut down to build up steam pressures.

SERVICE—Indicator cards were taken by the Standard Oil Engineer. Valves were set, new piston rings installed, and the engine started on Stanocyl Steam Cylinder Oil.

RESULT—The engine now operates satisfactorily on all loads—steam pressure is adequate and no time is lost in shutdowns. This, plus a 30% reduction in lubricating costs.

• • •

PROBLEM—To double flour production, a central states mill had to increase capacity of the Corliss engine. Boiler pressures were raised from 140 lbs. to 180 lbs. Engine speed was increased from 80 RPM to 120 RPM. Because of increased pressures and speed, frequent inspections were made. These soon revealed a marked increase in piston and ring wear. Oil carryover became a serious problem.

SERVICE—A Standard Lubrication Engineer analyzed operating conditions. A force feed lubricator and atomizer were installed. The engine was started on a high grade Standard cylinder oil, and feed adjusted to one pint of oil per million sq. ft. of rubbing surface.

RESULT—The reduced feed helped eliminate oil carryover—effecting a worthwhile saving in boiler cleaning labor and promoting safer boiler operation. Frequent inspections showed ring wear was reduced 75%—indicating adequate lubrication. Most important, the Engineer's recommendations answered this operator's question on how to avoid shutdowns and excessive maintenance.

AVOID SHUTDOWNS ON OVERWORKED STEAM ENGINES

• Are power demands pushing your generating equipment to the limit? If so, there are a number of questions which you'd like answered. How long will your equipment stand the added strain? How soon will shutdowns for maintenance seriously cut into power output? What can you do to avoid excessive repairs?

Standard Lubrication Engineers haven't all the answers, but they have helped many plants meet war-time loads. Examples of this service are briefly described at the left. See if they suggest ways one of these Engineers can help you. Then write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

STANDARD OIL STEAM CYLINDER OILS

OIL IS AMMUNITION . . . USE IT WISELY

STANDARD OIL COMPANY (INDIANA)

LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRICATION ENG

G . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICAT

NOT A BEARING FAILURE IN TWO YEARS...LESS TIME FOR OILING WITH STANODRIP

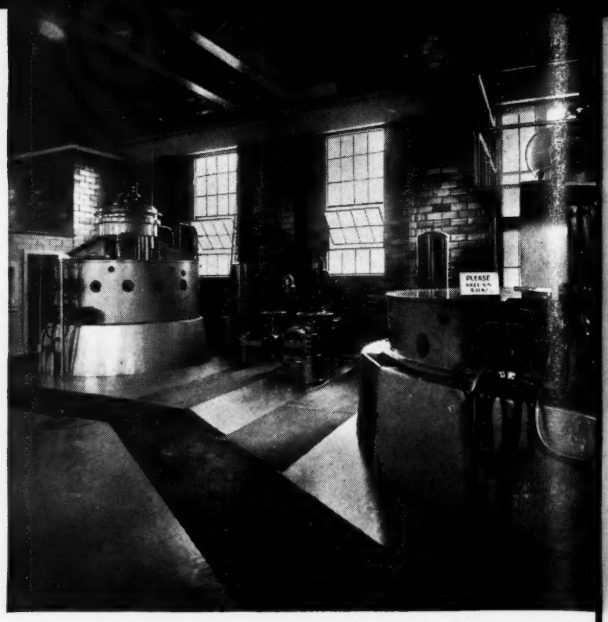
How can you save valuable production time and labor? Here's one answer. J. O. Schneider, Superintendent of the Cannon Valley Milling Company at Cannon Falls, Minn., briefly describes the results he got when he changed from a conventional engine oil to Stanodrip, a dripless oil.

He writes, "Since using your Stanodrip for the past two years we have not had a bearing failure or any trouble with bearings heating. This resulted in a considerable saving in production time."

On the saving in labor he says, "The cost of *oil application* has been reduced to one-third of what it was before using Stanodrip. Also, we're not having any trouble with oil on the machines and floor, *another saving in labor.* This oil costs more *per gallon,* but descreased consumption has made a 20% *net saving* on oil."

See if better lubrication and lubricants won't save much needed time and labor for you. A Standard Lubrication Engineer will help you find the spots.

(Left) J. O. Schneider, Supt. of Cannon Valley Milling Co., Cannon Falls, Minn., credits his change to Stanodrip lubrication with the complete elimination of bearing failures, a saving of two-thirds in oiler time, and 20% in oil costs, on the mills shown above.



STANOIL HAS LASTED 3 TIMES AS LONG AND STILL DOESN'T NEED TO BE CHANGED

When a conventional oil was used on the hydro-turbines pictured above, it had to be changed at least every six months. On one turbine the oil oxidized and turned dark in 10 days. That was the last fill of that oil.

When a Standard Lubrication Engineer was called in, he recommended Stanoil, which proved to be a wise choice. The same fill of Stanoil has now been in these turbines for a year and a half. There is no indication that it will need replacing for some time to come.

You'll find the same results with Stanoil in gear cases, circulating systems, and oil-lubricated bearings. Its high stability cuts shutdown time and maintenance by reducing oil replacement and oil system cleaning.

HERE'S WHERE YOU'LL FIND A STANDARD OIL ENGINEER

If you are located in one of the middle western states listed below, let a Standard Lubrication Engineer see if he can't help you save valuable production time, maintenance, labor or equipment by recommending better lubricants or better lubricating methods. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

COLORADO • ILLINOIS • INDIANA • IOWA • KANSAS • MICHIGAN
MINNESOTA • MISSOURI • MONTANA • NORTH DAKOTA • WYOMING
SOUTH DAKOTA • WISCONSIN

OIL IS AMMUNITION . . . USE IT WISELY

STANDARD OIL COMPANY (INDIANA

Their Lives Depend On "How Much...How Soon"

Avoid Frequent Shutdowns!

FREQUENT interruptions for repacking and replacement of gaskets and oil seals can be avoided by using quality materials at the start. GARLOCK quality products are helping industry maintain non-stop, all-out production schedules all over the country.

Garlock

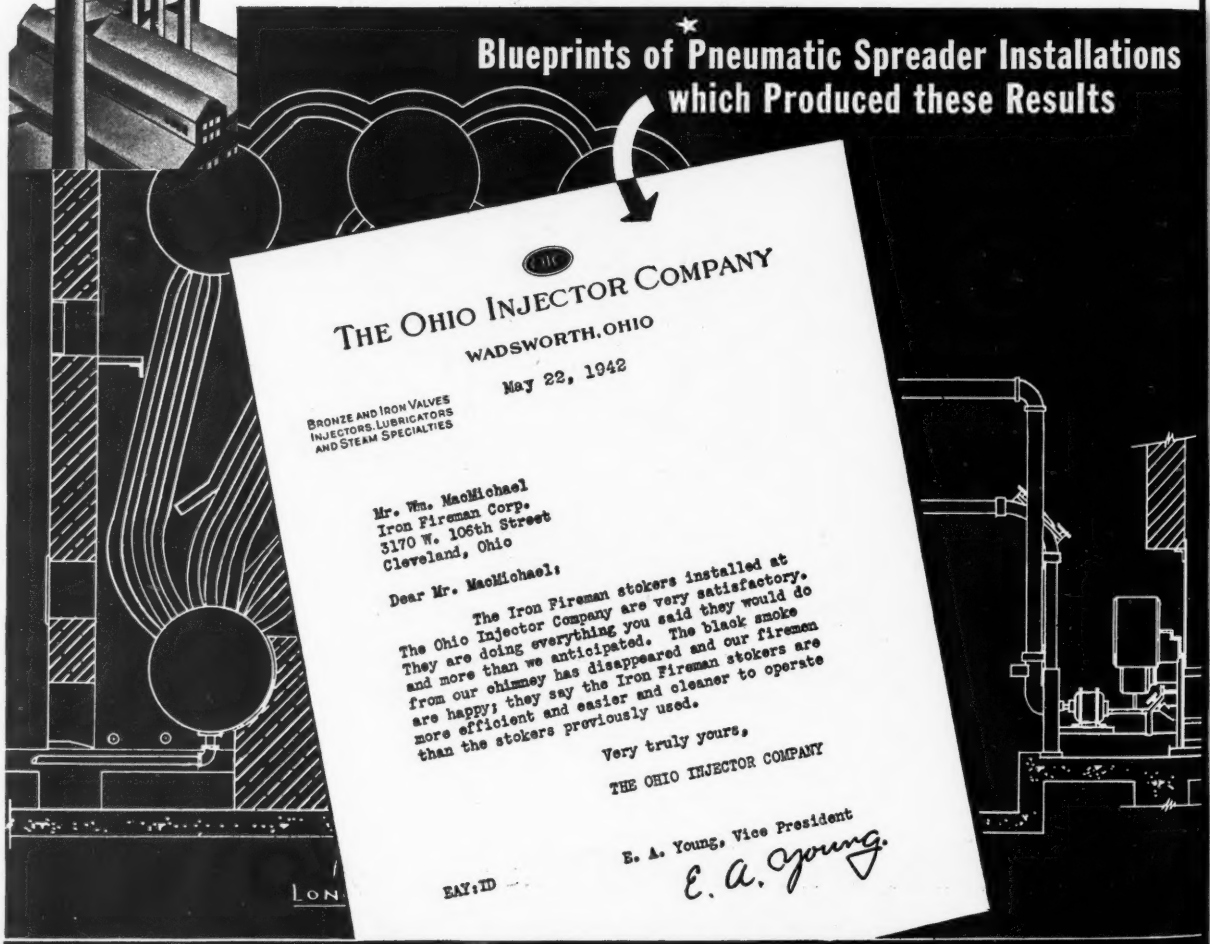
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Co. of Canada Limited, Montreal, Que.

Smoke is Waste!

IRON FIREMAN P.S.

Nuisance a

Blueprints of Pneumatic Spreader Installations which Produced these Results



THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

May 22, 1942

BRONZE AND IRON VALVES
INJECTORS, LUBRICATORS
AND STEAM SPECIALTIES

Mr. Wm. MacMichael
Iron Fireman Corp.
3170 W. 106th Street
Cleveland, Ohio

Dear Mr. MacMichael:

The Iron Fireman stokers installed at The Ohio Injector Company are very satisfactory. They are doing everything you said they would do and more than we anticipated. The black smoke from our chimney has disappeared and our firemen are happy; they say the Iron Fireman stokers are more efficient and easier and cleaner to operate than the stokers previously used.

Very truly yours,

THE OHIO INJECTOR COMPANY

E. A. Young, Vice President

E. A. Young

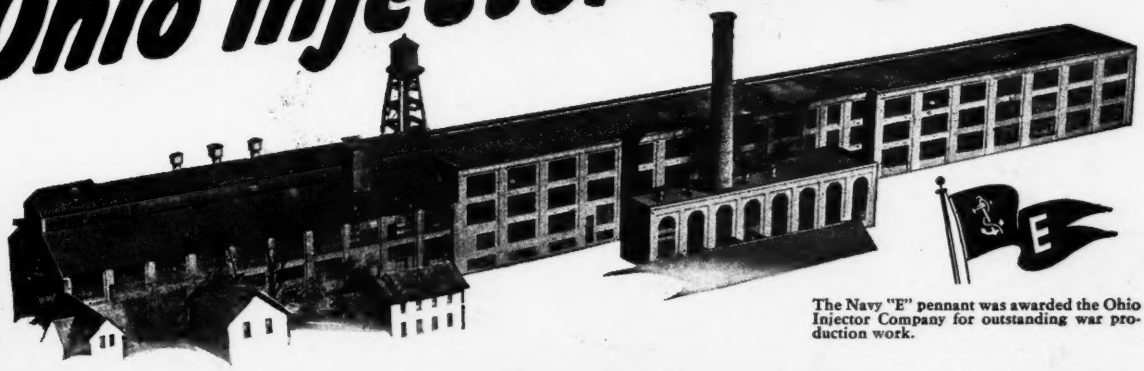
EAY:ID

IRON FIREMAN

THE IRON FIREMAN

Automatic Coal Stokers

STOKERS Abolish Smoke
Ohio Injector Company



The Navy "E" pennant was awarded the Ohio Injector Company for outstanding war production work.

More Power for War Industries

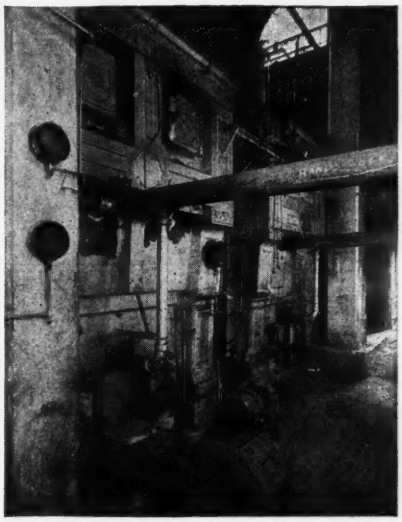
The Ohio Injector Company, well-known manufacturer of high grade valves and locomotive injectors, is doing such an excellent production job that the Navy Department recently honored it with the Navy "E" pennant.

Ohio Injector needed more steam—"plenty, and plenty quick," and Iron Fireman Pneumatic Spreader stokers are doing that big job. In November, 1941, the company installed two P.S. stokers under Sterling water tube boilers, to replace other coal firing equipment which had been responsible for a severe smoke nuisance. The obnoxious smoke situation was cleared up. Then Ohio Injector placed an order for a third P.S. stoker.

Saves Manhours

No coal shoveling is required with the Iron Fireman Pneumatic Spreader bunker-feed stokers, such as were installed at Ohio Injector. In these times when manpower is both scarce and valuable, bunker feed stokers help to win the production line battle.

E. A. Young, Vice President, the Ohio Injector Co., reports that the stokers save $6 a day in labor costs, alone. There have been no stoker maintenance costs.



Ohio Injector installation. In the foreground is the quiet, efficient fan for supplying forced draft to fire, and the volumeter which maintains exactly the amount of air needed for proper combustion.

Keeps Boiler Room Clean

Iron Fireman keeps the boiler room clean, because the coal is transported in overhead pipes to the boiler front, and into the furnace. Mr. Young reports, "When the Iron Fireman P.S. stokers were installed we painted the boilers aluminum, and the boiler room walls have been painted white.

"The boiler room has been changed from a dirty, dusty dungeon into a clean, pleasant place to work."

A clean, pleasant boiler room keeps employee morale high.

See P.S. Stokers at Exhibit

See our exhibit at the 15th National Exposition of Power and Mechanical Engineering, Madison Square Garden, New York, November 30 to December 4, 1942.

FREE BOOK on Pneumatic Spreader Firing

Contains full descriptions, capacities, operating data, etc., with layouts and photos of 10 actual installations. Sent free, on request. Write to Iron Fireman Mfg. Co., 3321 W. 106th Street, Cleveland, Ohio.

THE MAN WITH A DRAWERFUL OF TOMORROW

A suggestion for the man who is helping to win the war today

"SORRY," said the Chief Engineer, "but I can't do a darn thing for you! Our latchstring is always open to a Taylor Field Man," he continued. "But our new plant is all finished and there won't be any more new construction for the duration!"

"That's exactly why I'm here!", I said. "I realize you fellows have the opportunity of a lifetime—and I want to help you all I can!"

"How do you mean?" asked the Chief.

"I mean now that you can't do any more building, you can do some real planning for *after* the war." And I went on to tell him about some of the new developments Taylor is working on for the power field. The new Taylor mercury-less manometer for metering steam flow is just one example of how Taylor Accuracy, in its all-out war effort, is inventing new instruments that will help America win the peace.

The Chief pointed to a filing cabinet. "We're way ahead of you!", he said. "Here's a drawerful of post-war ideas. There's a lot of Taylor material in here now. But give me everything else you think we can use. We want to *plan with Taylor in mind!*"

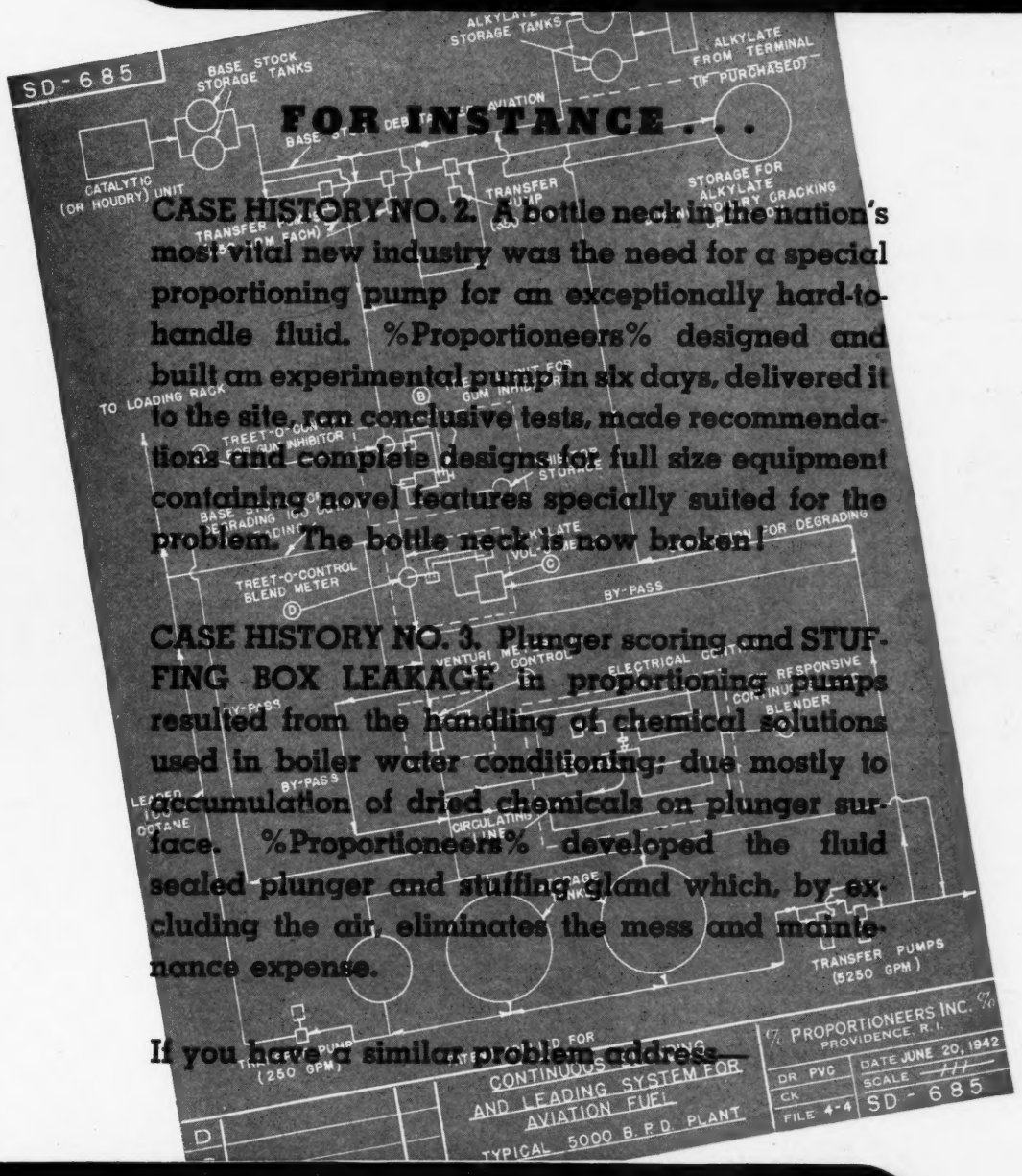
In their daily servicing of war industry, Taylor Field Engineers are amassing a wealth of experience that can help you in planning tomorrow—and in maintenance *right now!* Call your local Taylor office. Or write Taylor Instrument Companies, Rochester, N. Y. or Toronto, Canada. Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

★ ★ ★ KEEP ON BUYING U. S. WAR SAVINGS BONDS AND STAMPS ★ ★ ★

% PROPORTIONEERS %

SPECIALIZED ENGINEERING
ON PROPORTIONING PROBLEMS



FOR INSTANCE . . .

CASE HISTORY NO. 2. A bottle neck in the nation's most vital new industry was the need for a special proportioning pump for an exceptionally hard-to-handle fluid. %Proportioneers% designed and built an experimental pump in six days, delivered it to the site, ran conclusive tests, made recommendations and complete designs for full size equipment containing novel features specially suited for the problem. The bottle neck is now broken!

CASE HISTORY NO. 3. Plunger scoring and STUFFING BOX LEAKAGE in proportioning pumps resulted from the handling of chemical solutions used in boiler water conditioning; due mostly to accumulation of dried chemicals on plunger surface. %Proportioneers% developed the fluid sealed plunger and stuffing gland which, by excluding the air, eliminates the mess and maintenance expense.

If you have a similar problem address

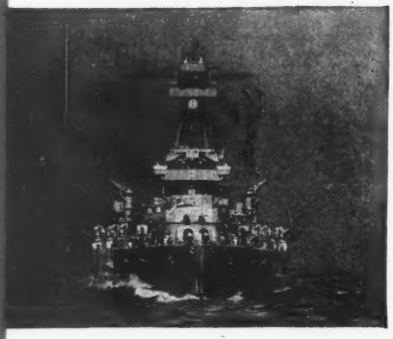
% PROPORTIONEERS, INC. %

46 CODDING STREET, PROVIDENCE, R. I.

WING Pioneered the A

WING AXIAL FLOW BLOWERS ARE IN USE IN INDUSTRIAL PLANTS EVERYWHERE

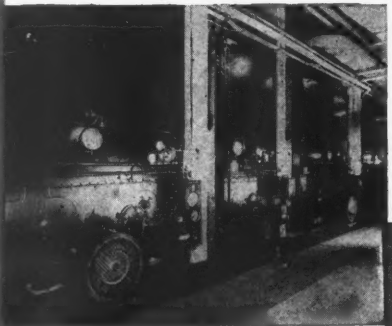
WING Axial Flow Blowers have been used in the Navy and Merchant Marine for over 4 years.



WING Axial Flow Blowers are being used on battleships, cruisers, destroyers, aircraft carriers, minesweepers, etc.

WING Type EMD Axial Flow Blowers have been used in this large defense plant for over 3 years.

WING Type COM Axial Flow Blowers are supplying forced draft to the boilers in the power plant of this airplane plant.



WING Type COM Axial Flow Blowers have been in use in this large educational institution for over 3 years.

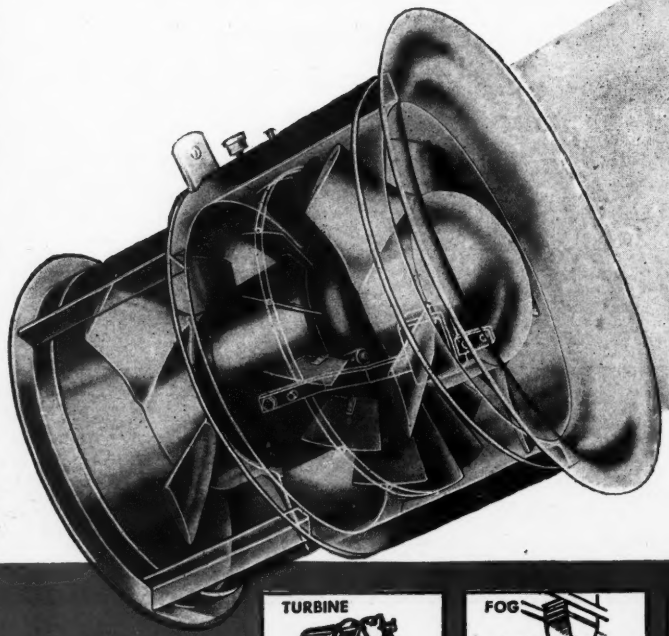
Type EMV
Type EMD

A remarkably compact single stage Blower, ordinarily used for static pressures up to 3" at moderate motor speeds. Type EMD is furnished with adjustable damper vanes.

WING pioneered the Axial Flow Blower for use in industrial plants over five years ago and because of its High Efficiency and fine Performance Characteristics WING has been building vast numbers of these fans for the U. S. NAVY and other branches of our armed forces

WING Single Stage (Type EMV or EMD) Axial Flow Blowers for static pressures up to 3" *WING Two Stage* (Type COM) Axial Flow Blowers for static pressures up to 7". These pressures are obtained even at the moderate speeds of standard commercial motors. The blowers may be controlled manually automatically. *WING* Turbine Blow incorporating these Axial Flow Fa generate much higher static pressur

Five years of highly satisfactory serv in marine and industrial applications a the best answer to the value of WIN Axial Flow Fans in forced draft or ve tilating work. While the Axial Flow Fa new to some in this field, the WING Ax Flow Fan is a time-tested veteran in t navy and many important industri



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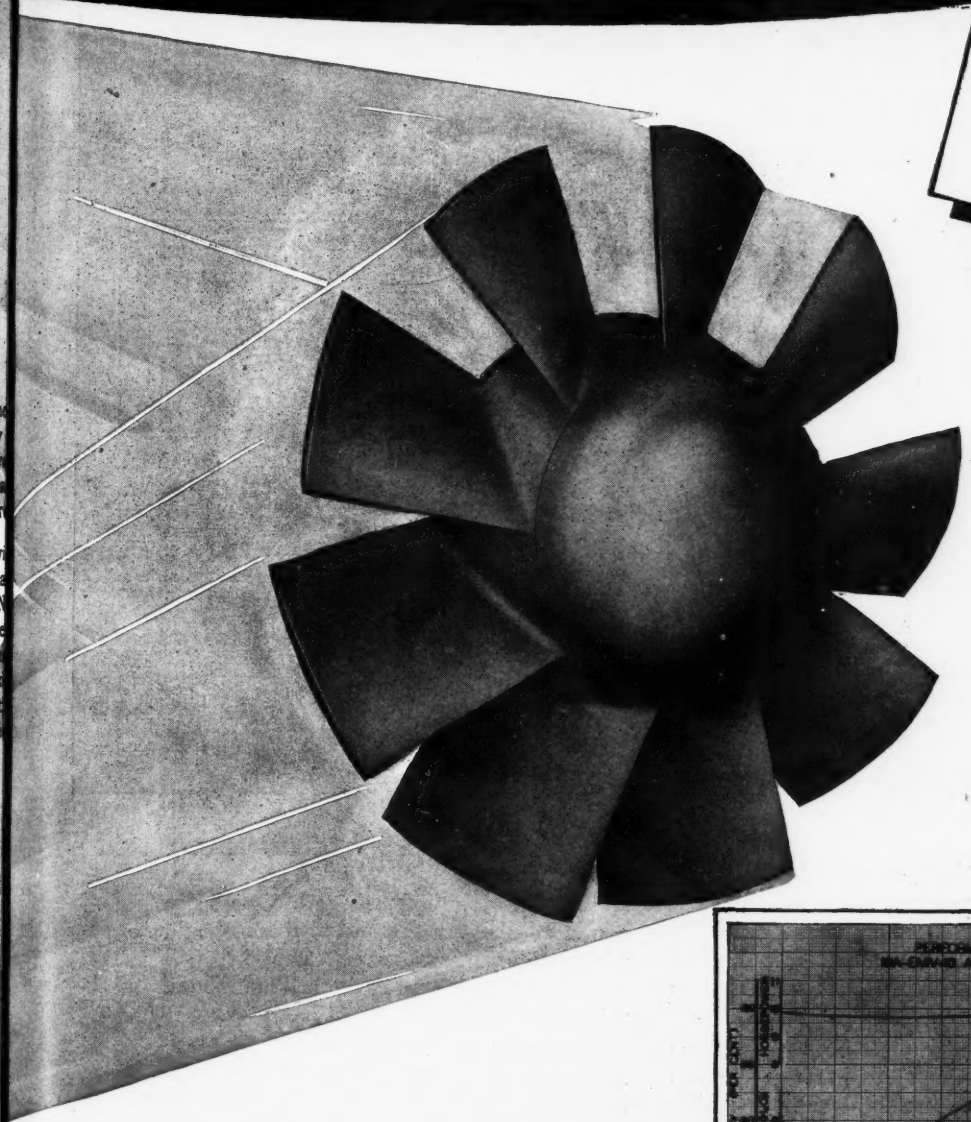

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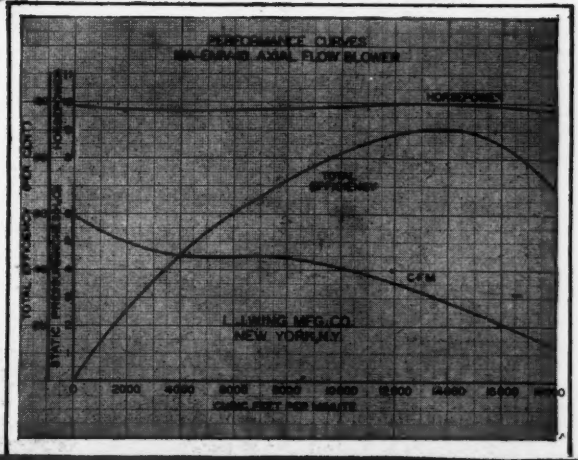

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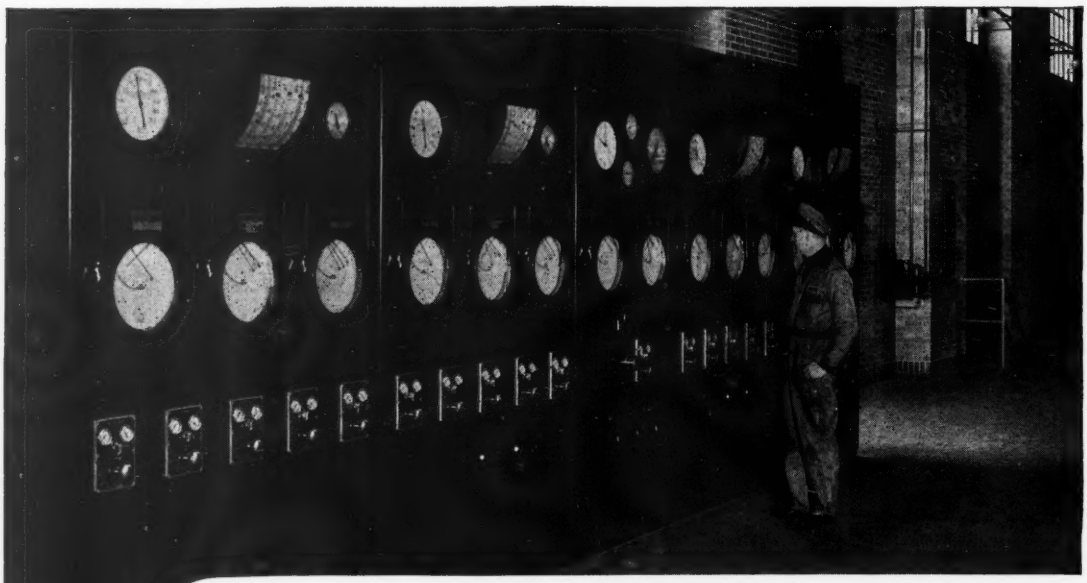

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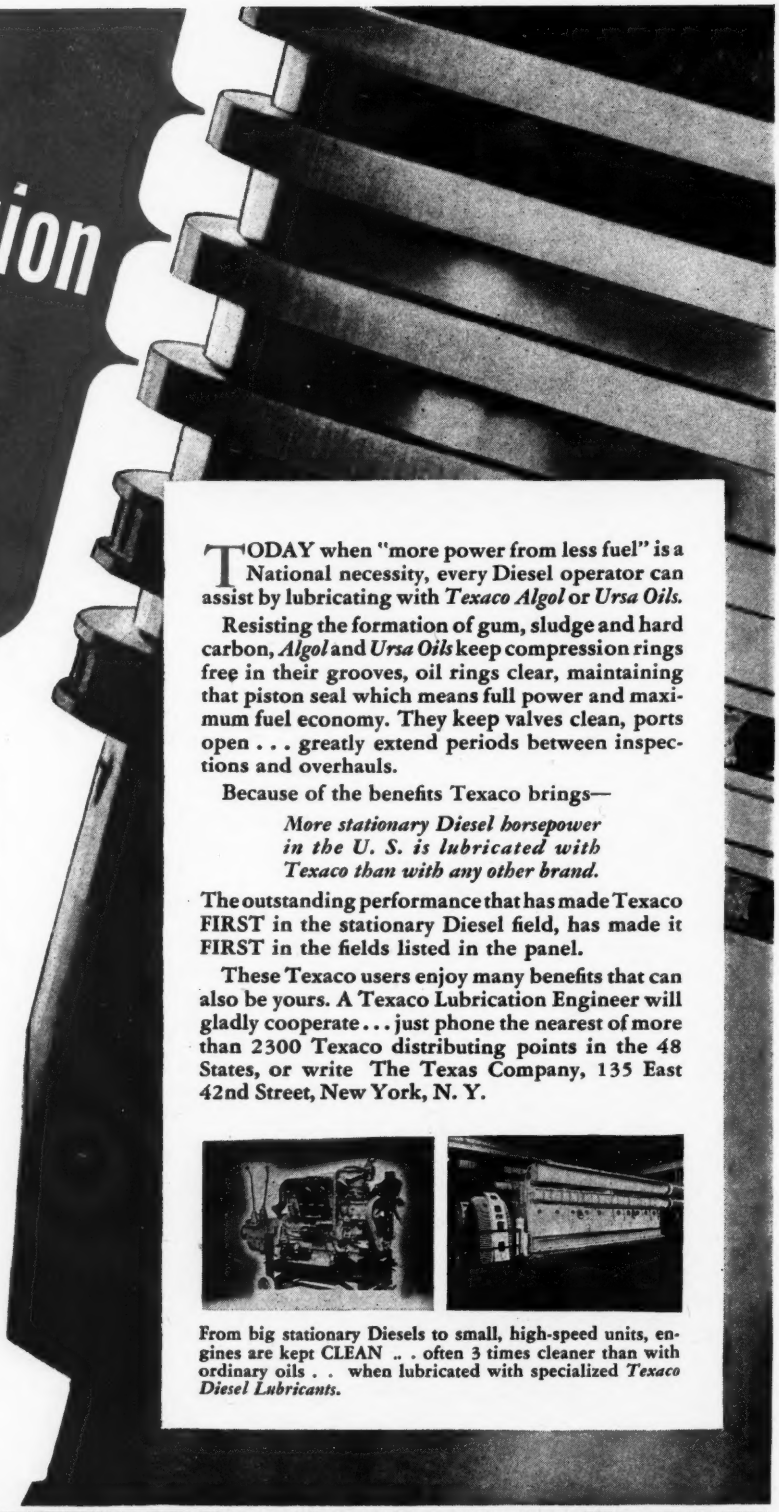

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POWER PLANT ENGINEERING

NOVEMBER, 1942
VOLUME 46, No. 11

Cover: Switchboard operators on duty in a modern industrial power plant. Photo, Hartford Steam Boiler Inspection and Insurance Co.

What Leaders Say 51
The Fine Art of Deception 52
Blackout Practice and Protection of Power Systems 53
Loads and Load Curves as Influenced by Blackouts. By Andrew W. Kramer 54
Utility Problems of the Blackout. By R. F. Cornell 58
Bombs and Bombing 60
Effect of the War on Foreign Power Systems 63
Protection of Plants by Camouflage 65
Blackout Materials and Window Protection 69
Maintenance of Protective Lighting. By George A. Eddy 73
What the Operator Wants to Know. By Alfred Iddles 77
Emergency Power Supply for Continuous Machining. By H. M. Martin 82
Shattered Belief 83
Instrument Aids for Turbine Operation. By H. C. Werner and G. V. Krenikoff 84
Correct Viscosity 87
Institution Benefits By Generating Power. By Anthony A. Fette 88
Treatment of Rapidly Changing Feedwater. By Kurt Illig 91
The Practical Engineer and Electrician 93
Softener Capacity Increased 118
War Production Discussed at A.S.M.E. Fall Meeting 120
War News from the Industrial Front 122
New Equipment 124
Manufacturers' Personals 140
News from the Field 146
New Engineering Books 154
For the Engineer's Library 160
Power Plant Construction News 168

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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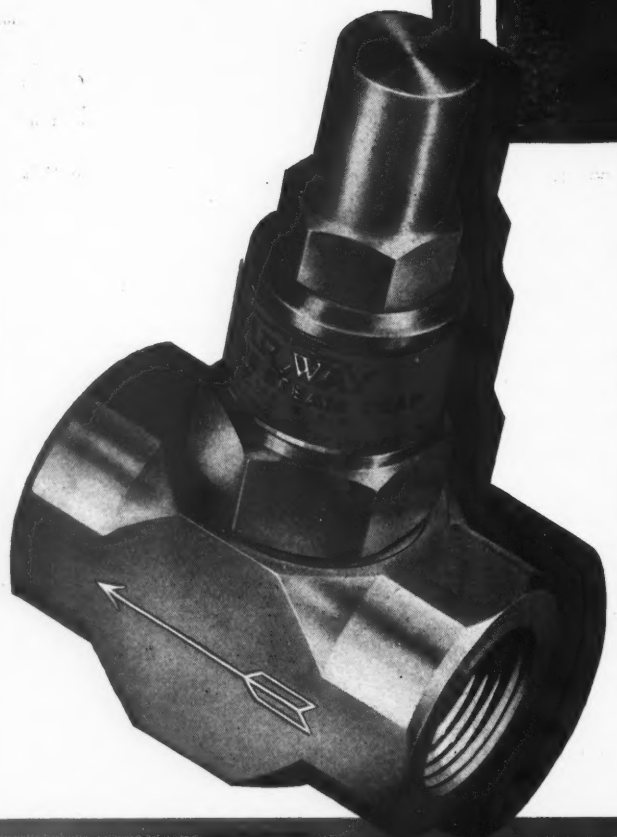

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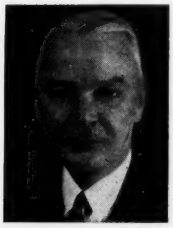
WHAT LEADERS SAY

Education and Industry vs. Manpower



Moffett Studio

By JAMES D. CUNNINGHAM

INDUSTRIAL management looks to the schools for its new employes. It wants young people endowed with the spirit of individual initiative, with faith in the traditions and institutions of America. It wants employes who have been trained to think and who have basic information which enables them to adapt themselves to their productive tasks and to the people with whom they work. Manufacturers believe in education—they are sympathetic toward it and enthusiastic about it. They want every American to have all the education he has the capacity to absorb.

Industry has an obligation to society to produce the goods on which our high standard of living is based.

Education has an obligation to society to educate young people to take their places as worthy citizens. It should teach not only objective facts but ideals and principles. It should help young people to develop a workable philosophy of life, not merely push youth out into the stream of life like a ship adrift without a rudder. Education should prepare youth to take positions not only as employes, but also as employers. Our future progress depends upon the incessant emergence of new enterprises. There must be men with the courage, the fortitude, the foresightedness, and the willingness to take risks and make sacrifices which are essential to private enterprise.

Manufacturers and businessmen are deeply interested in seeing to it that every American has an opportunity to receive the amount and the kind of education which will best serve him and society.

Business and industry cannot operate without employes, and it is to the schools of the nation that we must look for the young men and women who will have the ability and philosophy essential to maintain and advance America's industrial supremacy. The success of our industrial civilization depends not only on the development of the capacities to be effective employes, but also on the development of the qualities required to be good employers—enterprisers who will create new jobs, new improvements, new opportunities.

Our growing demands for new goods and new services cannot be satisfied by natural products alone. We must outdo nature in the laboratory. In every field of endeavor there is enough unfinished business to supply thousands of problems for industry and science to work on. Here are a few of the jobs that need to be done:

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These and many more are the problems facing today's youth, who, through the combined efforts of education and industry will form tomorrow's genius!

JAMES D. CUNNINGHAM, president of the Republic Flow Meters Co., is a well known personality in the field of instruments and controls, and also in the field of education. Mr. Cunningham began his career as a clerk in the Armour Glue Works in 1905. He became vice-president of the Clyde Machine Works in 1909 and in 1911 became president of the Steam Appliance Co., which later became Republic Flow Meters Co. He has been chairman of the board of trustees of the Illinois Institute of Technology since 1932 and is also a member of the board of directors of the National Association of Manufacturers. He is a member of the A.S.M.E. and the Western Society of Engineers, and also served as Second Lieutenant in the U. S. Army Air Corps in World War I. The material presented here is from a talk given by Mr. Cunningham at the semi-annual meeting of the A.S.M.E. held this summer in Cleveland

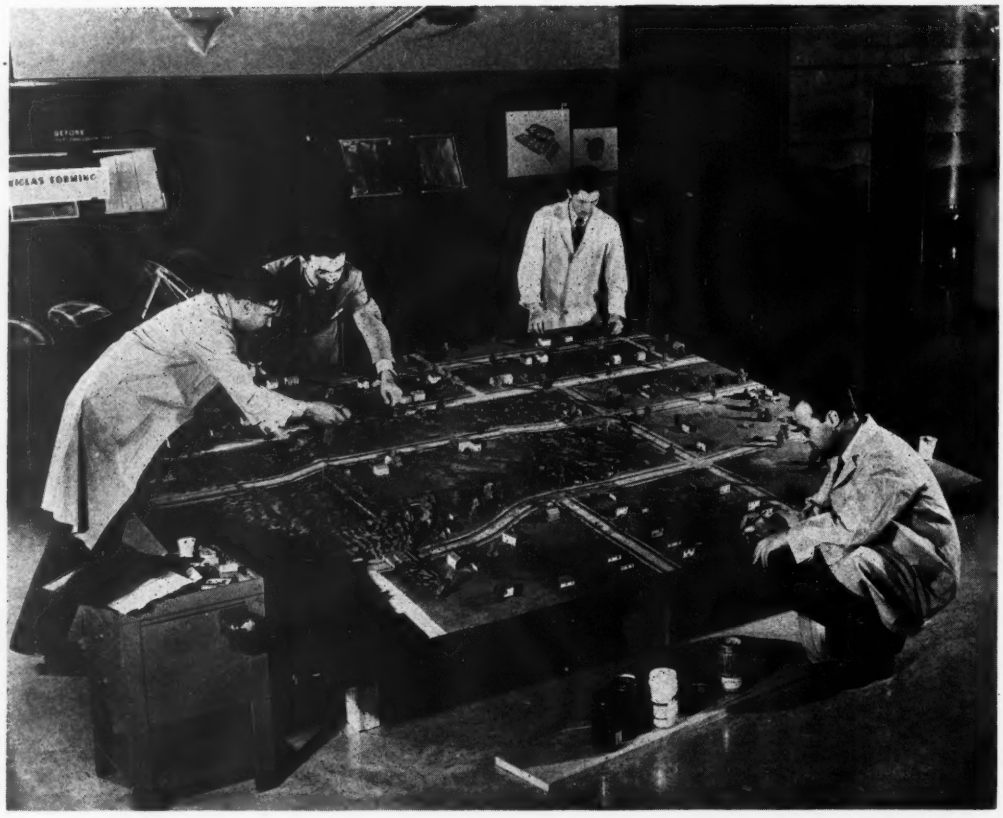


Photo. Courtesy, General Motors

The Fine Art of Deception

IT IS not often that public encouragement is given to the practice of deception. Deception in our usual way of life has a distinct negative moral value and though the world has always been full of it, it is not practiced openly except by spiders and alligators and such things. War has a way of changing everything, however, and it is because of the war that we see these men in the photograph, above, engaged in making themselves more proficient in the practice of deception. They are camouflage experts at General Motors—model makers and expert technicians building headaches for enemy observers. This picture shows them at work on a model, employing a technique which not only changes the appearance of the surrounding countryside, but also conceals an important (hypothetical) armament manufacturing plant. Camouflage, or "protective concealment" as it is technically known in this country is an important phase of power plant protection against air attack. It has received little attention here because, so far, we have not been subject to actual enemy air attack, but the problem is receiving attention. Some of the principles of camouflage are considered in the article on this subject on page 65 of this issue. The effective camouflage of power stations is extremely important in areas that are likely to be bombed and as a class, power stations present one of the most difficult problems in concealment because of the stacks. It is extremely important that concealment projects involving patterns, disguised planting, or major construction be preceded by thorough planning. No camouflage at all may prove to be better than camouflage poorly-conceived.

Blackout Practice and Protection of Power Systems

SO MUCH has been said and written in regard to blackouts and blackout practice in the short year that we have been actively at war that we are a bit hesitant about adding anything more to the discussion. Certainly, most everything that could be said on the subject has been said and in presenting this specialized section on blackout practice and the protection of power systems, we are laboring under no misapprehension that we can say anything new on the subject; that, therefore, is not our purpose. Our endeavor here largely is to analyze and correlate the knowledge and experience that has accumulated thus far and to describe the preliminary experiences of those who have been actively engaged in this aspect of civilian defense. Our particular interest, of course, is in power and power systems, and so far as possible the treatment of blackout practice as it is set forth in this issue, relates to power systems. ¶ In a country which is so, light minded, no pun intended, the blackout is a strange and depressing phenomenon. As pointed out elsewhere in this issue, the outstanding problem presented by the blackout is not of a technical nature. It is an elementary problem in human relations, but just because it is elementary, not necessarily easy of solution; it involves the task of abating confusion in a situation that inherently tends to create confusion. The great amount of time and effort involved in establishing a blackout throughout a large electric utility system is not generally appreciated by those who have not been confronted with the problem but a good idea of the magnitude of the job can be obtained from Mr. Cornell's article on blackout practice on the New York Power & Light system in this issue. ¶ With respect to plant protection by camouflage or by the construction of shelters and barriers the emphasis is on "caution". It is fitting that we should know about all of these things, but, situated as we are, it would not be wise to spend an undue amount of time, effort and material in erecting elaborate and expensive protective systems around our plants, important as they may be. All reasonable precautions should be taken, but it is a fact that the more optimistic estimates of the probability of enemy air raids come from civilian sources and until the military situation changes the wholesale expenditure of time and material in protecting plants cannot be justified.

LOADS AND LOAD CURVES AS INFLUENCED BY BLACKOUTS 54
By Andrew Kramer

UTILITY PROBLEMS OF THE BLACKOUT 58
By R. F. Cornell

BOMBS AND BOMBING 60

EFFECT OF THE WAR ON FOREIGN POWER SYSTEMS 63

PROTECTION OF PLANTS BY CAMOUFLAGE 65

BLACKOUT MATERIALS AND WINDOW PROTECTION 69

MAINTENANCE OF PROTECTIVE LIGHTING 73
By George A. Eddy

Loads and Load Curves As

A study of the load curves of various electric utility systems during blackouts reveals the fact that the utilities are able to handle the blackout load changes without the slightest difficulty. In some cases the drop in load during the blackout has been over 50 per cent of the normal load but no technical difficulties of any kind were encountered. Nearly all the blackout load curves available show the same type of pattern. The load starts to drop off before the blackout. The resumption of load is more rapid than the drop, and in most cases the retrieved load fails to reach normal after the blackout

By ANDREW KRAMER
Electrical Editor

THE MOST gratifying manifestation of the blackout as it has been practiced in this country since our entry into the war is the ease with which the electric utility systems have been able to meet the sudden changes in load imposed by the blackout. In no case thus far reported has there been any difficulty either in dropping the load at the start of the blackout or in picking it up again when the "all clear" signal is sounded. This speaks well for the flexibility and the effectiveness of control of the nation's electric generating facilities.

The principal problems imposed by the blackout are not of a technical nature; they are decidedly human. Modern boilers and electric generators together with the control equipment in use are adequate to meet almost any need. All the difficulties encountered in establishing and properly maintaining blackouts have been due to misunderstanding and improper coordination among the individuals responsible for the blackouts. Only a few days ago as these lines are being written there was considerable confusion and misunderstanding of signals on the occasion of an unexpected air-raid warning in the city of Boston—this 10 mo. after Pearl Harbor. The blackout involves an elementary problem in human relations, but as always where human relations are involved, it is a problem extremely difficult of solution.

These aspects of the blackout need not concern us here, however. The purpose of this article is to show how blackouts in various areas throughout this country and Canada have influenced the electrical loads in these areas. Enough cases have now been reported to show clearly that insofar as the handling of the sudden changes in load is concerned, blackouts impose no particular problem for the electric utility systems. True, so far, except for a few cases, most of the blackouts held have been for test or drill purposes only and, as such, the changes in load were anticipated hours and even days ahead of time.

Blackout practice in America is quite different from that in Europe. Much of our early information on blackout technique was derived from British experience and while this information is valuable in that it provides us with a background against which to develop our own technique, it cannot be applied directly to our own conditions.

As was pointed out in an article in the Edison Electric Institute Bulletin early this year,[1] in some cases these British experiences may actually be misleading to the public since it is the blackout itself rather than the entirely different situation in Britain which has been emphasized in the public mind. The greatest difference in the conditions applying to the two countries lies in the obvious dissimilarities in the geographical and military situations. When Great Britain undertook to blackout it was well understood that hostile air raids would occur, probably with great frequency and regularity; therefore, steps were taken to blackout the whole country for the duration of the war or until the military situation changed sufficiently to preclude the probability of damaging air raids. The electric loads were permanently adjusted to blackout conditions and even unexpected air

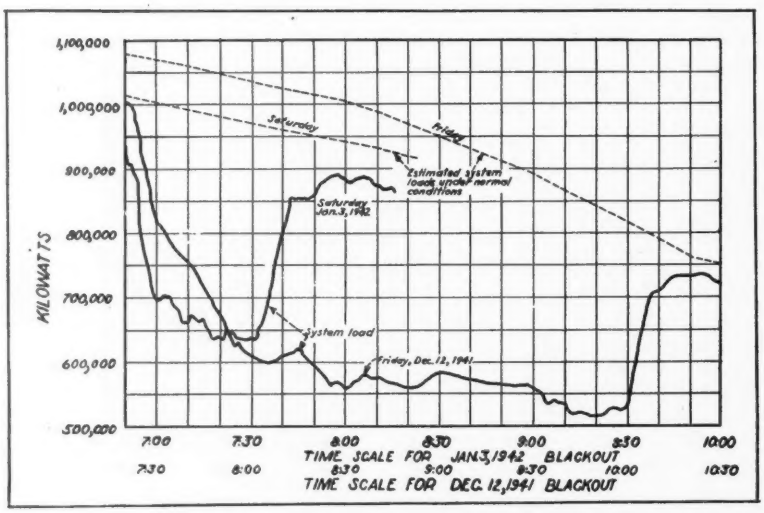


Fig. 1. Two of the first blackout load curves after our entry into the war, those of the P.G.&E. Co. system on Dec. 12, 1941, and Jan. 3, 1942

[1] Blackouts and The Electric Industry. P. 1, January, 1942.

Influenced By Blackouts

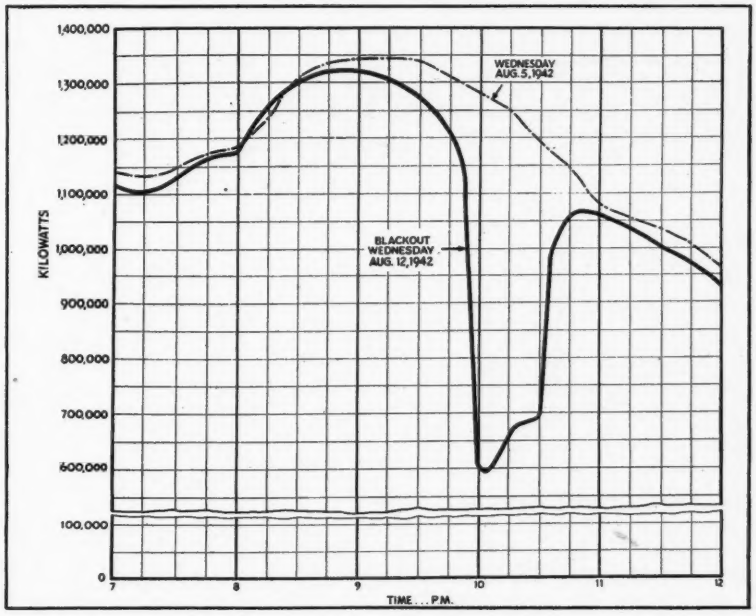


Fig. 2. Load curve on the Commonwealth Edison Co. system during the blackout in the Chicago area on Aug. 12, 1942

raids caused little fluctuation in the loads.

In America quite a different situation prevails. The air raid precautions are undertaken primarily for drill purposes. This is no responsible opinion that hostile air raids will actually occur under the present military situation. The military authorities are providing for every eventuality as they are bound to do, but the fact remains that the more optimistic estimates of the probability of raids come from civilian sources. While a few actual blackouts arising from military requirements have occurred in West Coast cities, the effects of these have not been very different as far as utility loads are concerned, as the effect of the prearranged blackouts for test purposes. In all cases, the transmission and distribution circuits remain energized and the blackout is effected by cutting off the lights very close to the points of use.

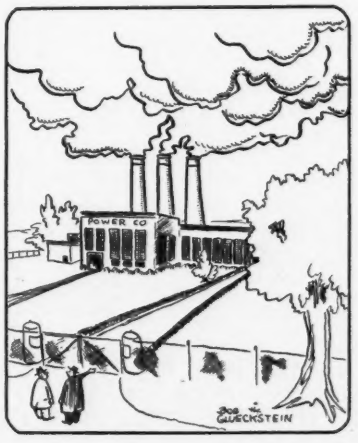
One of the earliest large scale blackouts in this country after the attack on Pearl Harbor was the one in the San Francisco area on December 12, 1941. This blackout and a subsequent one in the same area on January 3, 1942, gave the first answers to the question as to what occurs on a large integrated system when loads of 400,000 kw. are suddenly dropped.

The load curves of these two blackouts on the Pacific Gas & Electric Co. system are shown in Fig. 1. The first blackout occurred on December 12, between 7:20 and 10:00 p. m. The affected area comprised some 7000 sq. mi., approximately 6.5 per cent of the P.G.&E. service area. This area contained about 70 per cent of the total system load. As shown, the drop in load was exceptionally rapid during the first 10 min., in which time almost 200,000 kw. was dropped from the system. This is accounted for by the cutting off of the major metropolitan load plus street lighting in the entire area. The blackout area included not only the whole San Francisco Bay district but an area extending northward into the Sacramento Valley as far as Marysville. After the initial 10 min. period, the rate of load decrease was slower due to the fact that means of relaying the news to the public had not been properly developed. Even so, the load dropped from slightly over 1,000,000 kw. at 7:20 p. m. to around 600,000 kw. at 8:05 p. m. This drop of approximately 400,000 kw. represented some 40 per cent of the system load. Thereafter the load fluctuated considerably but showed a gradual decrease until 9:50 p. m. when it reached its lowest point, 526,000 kw.

The blackout on January 3 was less extensive than the one just described, but as shown by the load curve in Fig. 1 it was very much more effective. In this case the area involved comprised only the San Francisco Bay district. The load dropped almost 300,000 kw. in the first 30 min. The maximum 1 min. drop was 64,000 kw. between 6:54 and 6:55 p. m., 6.8 per cent of the total load.

A comparison of the two load curves of these first major blackouts after our entry into the war with others obtained during subsequent blackouts in other cities is interesting, since nearly all of them reflect the same characteristics.

The effect of greater planning and more careful preparation is shown by some of the more recent



"Before the war it was a nuisance. Now they call it a protective smoke screen"

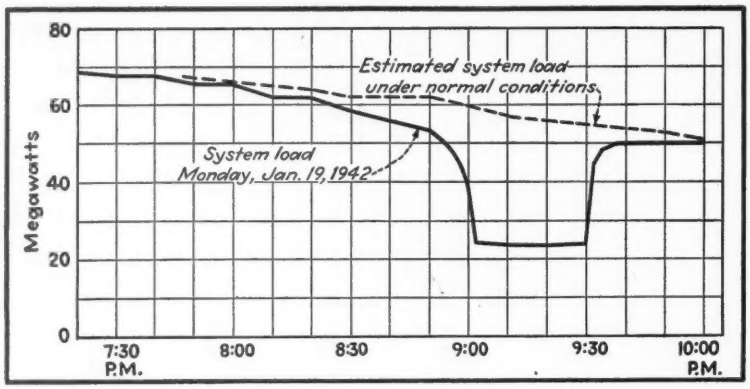


Fig. 3. Dallas Power and Light Co., Jan. 19, 1942

blackout load curves as for example that of the Commonwealth Edison Co. for August 12 in the Chicago area. This curve is shown in Fig. 2.

In this case, the blackout was carefully planned weeks in advance, evidence of which is reflected in the way the load started to drop off long before the onset of the blackout. The blackout was scheduled to commence at 10:00 p. m. As shown, the load started to drop off appreciably at 9:00 p. m., about ½ hr. earlier than usual, and by 9:45 p. m. when the warning sirens first sounded, it had receded to 1,000,000 kw. which was about 300,000 below normal. At 10:05 p. m. when the totalizing meters in the central load dispatcher's office indicated a load just under 600,000 kw. the load had dropped 50 per cent. This was the low point. It will be noted that just after 10:05 p. m. the load began to rise. This is accounted for by the fact that at this point the war production plants again switched on their lights after a 5-min. "token" blackout. The low point, 590,000 kw., was approximately 700,000 kw. below normal. During the remaining 25 min. of the blackout the output rose slightly and by the time the "all clear" signal sounded, had climbed to 700,000 kw. The reading at 10:35, 5 min. after the blackout, was 935,000 kw. and it was 1,055,000 kw. at 10:45 p. m. At 11:00 p. m. the load was 1,060,000 kw. and thereafter it followed the usual night time downward trend.

Effect of Blackout in Chicago Not Drastic

At the present time, about one-half of the electricity generated in the Chicago area between 10 and 10:30 p. m. is used in industrial plants. Because such a high percentage of these plants are engaged in war production work and continued operations during the air raid test, the effect of the blackout on the district's total electrical load is not as drastic as might be expected. Another factor tending to cushion the drop is the sizable decrease in electricity use normally experienced at that time of the night as a result of reduced residential lighting and street car, elevated and suburban train traffic.

In this case also, because of their vital role in supplying power to war production industries, generating stations and switching centers of the Commonwealth Edison group of companies were completely blacked out only during the first 5 min. of the air raid test. Permission to switch on the protective lighting at these locations after 10:05 p. m. was granted by the War Department.

These two examples of load curves during blackouts set the pattern for practically all of the blackouts held in various areas during the past year. It is a characteristic that whenever the blackout is held after 9:00 p. m., the load after the blackout seldom regains normal level. Apparently many people, knowing that the blackout is to take place, solve the problem of maintaining the blackout by simply going to bed. Pre-arranged blackouts also reveal, quite understandably, a disposition on the part of the people to curtail their use of electricity on the average of an hour before the alert signal is given. In some instances there have been signs of sagging below normal as early as 5 hr. before the alert signal.

Study of various blackout load curves show that the recovery period is usually less than one-fourth as long as the decline period. This is particularly true of prearranged blackouts. On the contrary, the unexpected blackouts on the Pacific Gas & Electric system around San Francisco showed a resumption period much longer than the drop-in-load period.

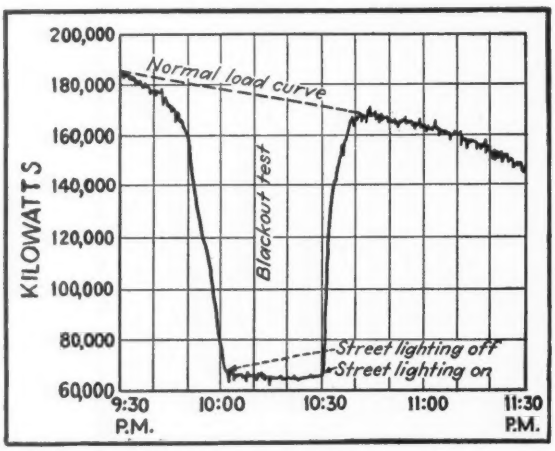


Fig. 4. Toronto Hydro load, pre-war blackout on Sept. 10, 1941

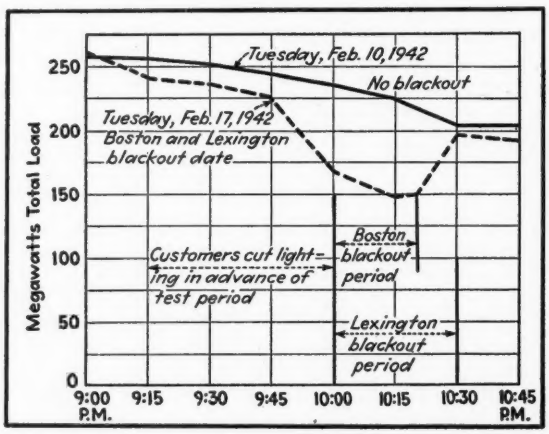


Fig. 5. The Boston Edison Co. load curve during the blackout, Feb. 17, 1942

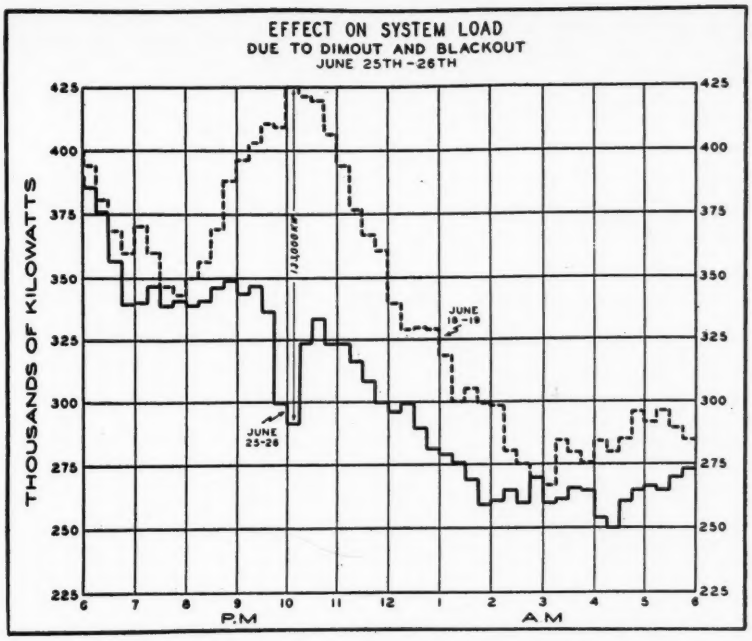


Fig. 6. Effect of blackout on June 25-26 on the Duquesne Light Co. system

In an analysis made by the Electrical World[2] it was pointed out that the maximum rate of load drop in megawatts per minute was that at Dallas, Texas (Fig. 3) at 40 per cent of the value when the sharpest decline began. The average for ten companies was 21 per cent in megawatts per minute.

The rate at which resumption can occur on a large system depends somewhat upon the type of generating facilities used on the system, whether steam or hydro or both, but in no cases so far reported have the limitations of any particular system in this respect been reached. Commenting on this aspect of the problem, F. R. George of the P.G.&E. system expressed himself as follows:[3]

"The rate of increase for large capacity steam units during the initial load stages is approximately 2000 kw. to 5000 kw. per min. and increases to as much as 15,000 kw. to 20,000 kw. per min. from about 20 to 100 per cent of the unit's capacity. The rate of load increase on the various hydro plants varies greatly. Some turbine units with tunnel, penstock and other hydraulic limitations have load increase increments comparable to the large steam units. Most of the impulse units can reject the water into the tailrace and by merely raising the nozzle body can arrive at full load within a few seconds. If load is added by opening the needle, it may require some 30 sec. to 3 min. to obtain full plant load, depending on local conditions."

The important conclusion which can be reached from a study of the various blackout load curves available is that the electric utility systems seem to be able to handle the blackouts with about the same ease as they formerly handled the usual noon-hour industrial load dips. In no case reported has there been the slightest difficulty in handling the load fluctuations. Control equipment is adequate and no system disturbances have resulted in any instance.

Of interest in this respect is the load curve of the Detroit Edison Co. and the corresponding frequency record shown in Fig. 7. This record was for a blackout held in the Detroit region on Sunday evening, May 3 of this year. Again, here can be seen a gradual dropping off of the load some time before the blackout. The blackout began at 10:00 p. m. and, it will be noted, the load started upward shortly afterward. The natural question asked by anyone studying the curve is, "Why did the load start upward at this time when the city was blackest?" In this case the answer is somewhat different than was the case with the Commonwealth Edison Co. curve in Fig. 2. According to the Detroit Edison Co. engineers, the increase was due largely to the normalizing of frequency on the system. The fact that the system frequency did not vary as much as three-tenths of a cycle during the blackout period is an indication of the efficiency with which this problem was handled.

The handling of the loads during blackouts naturally involves close coordination between the various divisions of the generating plant. As pointed out by the Detroit Edison Co. engineers in referring to the curve in Fig. 7, their firemen managed this rapid load drop without popping a single safety valve on the boilers. Modern boilers and fuel burning equipment properly handled are sufficiently flexible to handle any change in load imposed by the blackouts.

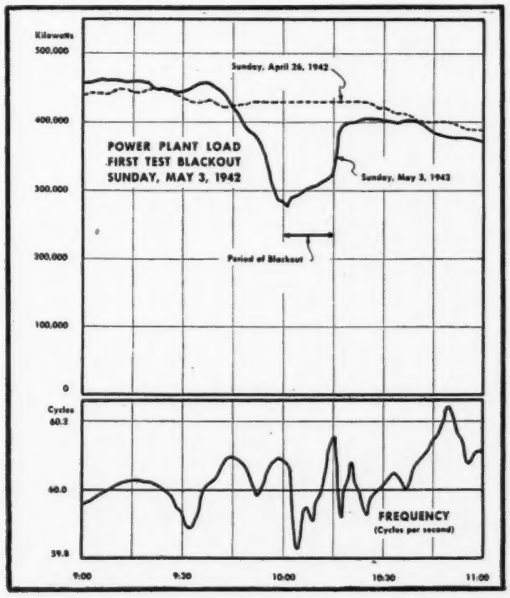


Fig. 7. Load curve for Detroit Edison's blackout on May 3, 1942, with corresponding system frequency record

2Plants Take Blackout Load Changes Comfortably. P. 56, Aug. 22, 1942.
3Electrical World. P. 58, Aug. 22, 1942.

Utility Problems of The Blackout

The amount of time and effort involved in making preparations for a large scale blackout by utility systems is not generally appreciated by those who have not had experience in such work. Such systems have a variety of properties, unattended substations, automatic hydroelectric plants, river-crossing towers, etc., all having lighting equipment and it is a problem of considerable magnitude to find ways of putting these lights out in cases of blackout. As the author of this article put it, he has always been in a position where he got particular hell if the lights went out; now, however, with the necessity of blacking out, he finds himself in a position where the reverse is true—he hears about it if the lights stay lighted. The work done in this field by the New York Power & Light Corporation should be of interest to all electric utility men concerned with this problem even if to a far smaller degree

by R. F. Cornell, Chief System Operator, New York Power & Light Corporation

THE OPERATING TERRITORY of the New York Power and Light Corporation, which, in general, is about the same as the Eastern Division of Niagara Hudson, consists roughly of the area in New York State east of Utica to the New England boundary and extending from the heart of the Adirondack Mountains on the North to just south of Albany on the West bank of the Hudson River and south to the Duchess County line on the East side of the Hudson River. We have an installed capacity of about 80,000 kw. steam generation and 220,000 kw. in hydroelectric plants. We are interconnected with the Consolidated Edison Company on the south, the New England Power Company on the east, and the balance of the Niagara Hudson System on the west.

R. F. CORNELL, the author of this article was graduated from Massachusetts Institute of Technology in 1924. After graduation he worked for three years as a switchboard operator and system operator for the Narragansett Electric Company at Providence, R. I. In 1928 he left the Narragansett Electric to go with the New York Power and Light Corporation and from 1928 to 1933 worked as load dispatcher and system operator for that company. Since 1933 he has been chief system operator with complete responsibility for all dispatching on the New York Power and Light system. His wide experience in the operation of a large utility system qualifies him well to write an authoritative article on utility blackout problems and procedure

In the latter part of 1941, when it became evident that the country would have to be prepared for blackouts, many electric power companies, including our own, felt that they were faced with a really serious problem. Now, in late 1942, having been through all sorts of blackouts—prearranged and surprise, daylight alerts, dimouts, etc.—we can truthfully say that the problem has not been too difficult.

The first thing, of course, was to survey our system to find out just what would be necessary in the line of rearrangement of our feeders, so that the street lights could be put out promptly at the request of the proper authorities. After many conferences among our engineers and with civilian defense units and local government bodies, it was decided that, wherever possible, series circuits controlled by time clocks or photoelectric devices would be cascaded onto existing series circuits controlled from attended substations. This method would use much less of the so-called critical materials and, in addition, would require less labor. Next were the street lights in the outlying or smaller communities, where no regular attendant is maintained at the substation. After being assured of cooperation with the air-raid wardens, key switches controlling these lights were installed at easily accessible points and keys given to the local air raid wardens.

Methods and Materials

While our distribution people were getting our street lighting system ready for the first blackout, our plant men were searching for means and material to accomplish a blackout of our operating properties. The first thought, of course, was to paint all windows black, but after a few trials this was found to be unsatisfactory, due to the badly depressing effect on personnel. Also, in most of our plants windows must be used for ventilation. After many experiments, wooden frames covered with plywood or heavy building paper were installed over most of the plant windows, extending below the windows far enough to form a light trap to allow for ventilation. These shutters are usually hinged so as to allow for opening when not needed. Office buildings which must carry on during blackouts have windows equipped with heavy light-proof draperies.

Communication Problems

Now that we were able to accomplish a blackout, how were we to dispatch the signal to the various plants scattered all over the eastern part of New York State?

Many companies set up their System Operators or Load Dispatchers to broadcast this warning over the regular dispatching channels. However, we felt that at the time of a real air raid, our System Operators should be free of this routine so as to be able to devote their time to actually running the system. With this in mind, we arranged for the alert signals to come from each of the seven civilian defense warning centers to our local service dispatchers in these respective areas. These service dispatchers in turn broadcast the warning to key stations who, in turn, pass it on by telephone to other stations until all stations have been notified. As, during some tests, possibly only one or two of these areas will be blacked out, there must be no overlapping of this notification, i.e. each Service Dispatcher will notify only a group of stations in his own civilian defense area. The Service Dispatcher also notifies the System Operator of all alerts, so that the System Operator knows at all times what sections of his system are to be blacked out.

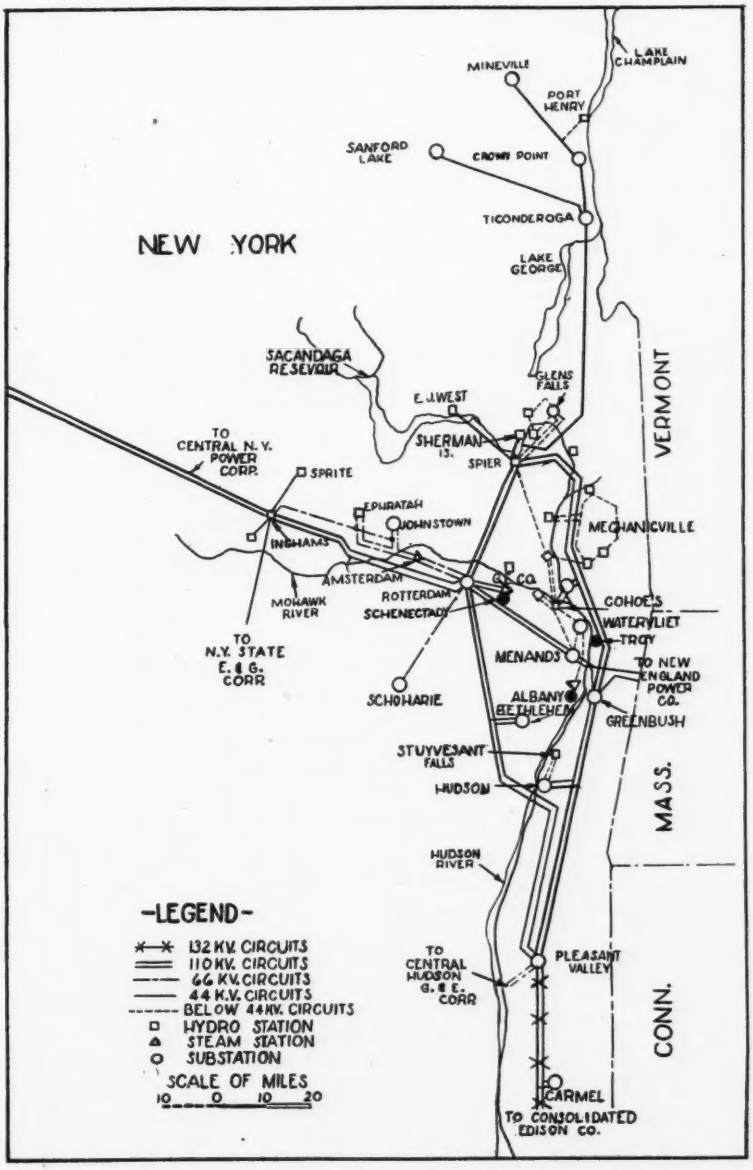
The System Operator on our system does just as his title implies. He runs the system. In our System Operator's Office, we have centralized the load supervision, trouble dispatching, and maintenance dispatching. Therefore, there was much planning to be done in preparation for a blackout or possibly an air raid. The first thought, naturally, was what effect dropping large blocks of load or picking them up again on the all-clear would have on our system. After considerable study of our loads, area by area, it was decided that in the worst condition we might face, i.e. a blackout of our entire operating area, the loss of load would be no greater, and probably not so great, as the loss of our largest interconnections due to a lightning surge. As we have never experienced any great difficulty in handling such load surges, this problem did not appear to be too serious.

Load Considerations

It was decided to transfer as much of our load as possible from steam to hydro stations on receiving the yellow alert. We are fortunate in having a large percentage of our capacity in hydro stations with a large amount of pondage available and with no particular limitations on the rate of loading or unloading them. By this load transfer at a controlled rate we are able to prevent rapid load changes on our steam generating stations which would give us poor boiler room economy. When the red signal is received, the System Operator will drop load from these hydro stations in a normal manner, either maintaining normal frequency or holding true tie line load with connecting companies, depending on whether we are regulating frequency or holding tie line load.

The next problem on the list was the possibility of having to send emergency men out during a blackout. As there had been no general system set up giving men permission to travel during a blackout, or providing approved blackout lighting for automobiles, we decided to cover the necessary key points where men might be needed. Men were sent to these points on the System Operator's orders during the yellow and blue warning periods. However, we have recently received a good supply of blackout lighting equipment for our cars and are training our personnel in the use of it.

The foregoing has given a general picture of our preparations for a blackout. As to our actual experience throughout the many



Outline map of the New York Power & Light Corporation system showing the location of the various types of generating stations and substations

test blackouts in the past nine months, it has been, in general, good. Cascading of our street lights, about which we all had some misgivings, has worked out very satisfactorily—so well, in fact, that much of it will remain after the war. We have had a much better record of street light operation than under the old time clock scheme and fewer complaints due to failure of lights to come on at the proper time. In this connection, one thing is of prime importance, and that is that when a series circuit which controls other cascaded circuits is in trouble, the controllers must be manually operated as soon as possible, restoring all other circuits before time is used up in trying to restore the one circuit.

Use of Air-Raid Wardens

Air-raid wardens have cooperated with us very well in operating the various key switches controlling our lights at remote points. Due to the recent orders of the Army, which requested that we leave all protective lighting on during test blackouts, it has been necessary to cover most of our unattended stations during test blackouts in order to prevent wardens from turning them out, as, in general, the wardens do not know whether the blackout is a test or an actual raid. Our present policy is to put out our protective station lighting for 1 min. during the test in order to show cooperation with the local authorities and also to test its effectiveness.

As to the effects on the power system in general, they have been well within our ability to cope with. The load drop and subsequent pick-up in each case has been handled with a minimum of disturbance to either the frequency or our tie lines with connecting companies. While we have had load drops of approximately 60 per cent of the normal load in the area blacked out, the average load drop on our system has been between 30 and 40 per cent, usually taking place over a period of from 3 to 5 min., and being ordinarily restored at a slightly greater rate, with usually about 10 per cent of the normal area load remaining off for the balance of the evening. If a blackout has been well advertised, the area load is usually off about 10 per cent as much as 1 hr. before actual blackout time. On an unexpected blackout, loads previous to the actual alarm are about normal. After a blackout lasting only about 10 min., the load will restore to almost normal value, but after one lasting 40 min. or more, about 15 per cent of the normal load stays off for the rest of the evening.

In summing up, I wish to say that out of the welter of confusion which arose when we who had for many years been trying to keep the lights burning were suddenly ordered to put them out, we have been able to develop a smooth operating routine. Much of our success has been due to the fine cooperation shown by local municipal authorities and the New York State Civilian Defense Organization.

Bombs and Bombing

Despite much discussion of the subject the question of protection against aerial bombing in this country is still only an academic one. With the present military situation it would be unwise to indulge in the wholesale erection of bomb shelters and barriers to protect equipment, but certain precautions can and should be taken and these are considered in this article. Test results obtained at the Aberdeen Proving Ground provide valuable information as to what type of shelters are most effective

IF WE WERE closer to the enemy the question as to what we should do to protect ourselves against air attack could be answered with greater ease than it can be now, when the question of enemy air attack is still purely an academic one. While the possibility of air attack by the enemy in this country cannot be ignored it would be unwise to spend an undue amount of effort and money in protecting ourselves against air raids until the probability of such air raids is more certain than it is at the present time. Reasonable precaution should be taken and our practice blackouts are a step in that direction, but the wholesale and indiscriminate erection of barriers against aerial bomb damage would not be employing our strength and effort in carrying on the war to best advantage.

There are, however, structures of great importance and strategic value on which a certain amount of effort may well be spent in protecting them against bomb damage. Power stations and distribution centers come under this classification and the least that can be done in their protection is to provide proper fire-fighting equipment to combat fires started by incendiary bombs.

It is, of course, practically impossible to provide protection against a direct hit of a heavy demolition bomb, and fortunately, not so necessary as it is to protect against other damage. Events in Europe have proved that 90 per cent of all casualties are not caused by the direct hit of the bomb, but by flying splinters and debris and falling shrapnel and bullets from one's own guns. Protection against these latter can be provided at reasonable cost and in the case of important equipment this might be done in some cases, but even here it is best to be conservative. As long as the United Nations have control of the seas and all possible bases within striking distance of continental United States, we do not need to fear sustained air attacks. Sporadic raids, however, are within the bounds of possibility and it will do no harm for us to know something about the various types of bombs used in aerial attack and their destructive effects.

The four types of bombs to guard against are shown in Fig. 1. They are, A, the 2-lb. magnesium-thermit incendiary; B, the 50 and 100-lb. oil bomb which is also an incendiary; C, the 30-lb. fragmentation bomb which bursts into lethal splinters, and D, the demolition bomb. The latter varies in weight from 100 to 2000 and even 4000 lb.

Protection from the splinters of the fragmentation bomb and the demolition bomb is best afforded by sand-filled reinforced concrete barriers. Such barriers can be erected around important transformer installations and even inside power stations, but they are expensive and at the present time their use in this country has been extremely limited. Almost all the protective measures that have been taken in this country have been with respect to incendiary bombs. In addition to the usual fire extinguishers available in most industrial plants, buckets of sand and long handled shovels constitute the most common equipment for fighting incendiaries.

There are two phases to the burning of the magnesium bomb. The first stage is the violent burning of the thermit igniting charge within the body of the bomb, when melted metal and flame spurt for several feet. During this active eruption, which lasts for about a minute, no attempt should be made to approach the bomb. It is important to watch and wait at a safe distance, especially since the bomb may contain an explosive charge which may go off during the thermit reaction. This thermit reaction ignites the magnesium, which then continues to burn for 10 to 20 min. if left undisturbed. In this second stage the bomb can be approached closely and fought with water spray or sand.

Extinguishing Incendiaries

All types of extinguishers discharging water, or chemicals dissolved in water, can be used directly on the bomb itself, if their normally solid streams are converted into a fine spray. The use of the water spray serves two purposes. It speeds up the combustion of the bomb so that it burns out quickly. Secondly, it serves to wet down the area around the bomb and thus restrict the spread of fire. It will ordinarily require two, 2½-gal. extinguishers to dispose of one bomb and its surrounding fire.

A coarse spray of water helps control the burning bomb; a solid stream causes it to flare up explosively. The solid stream of the extinguishers, however, can be used on fires started by the bomb.

If the bomb can be approached before it has set fire to its surroundings dry sand can be used effectively. The sand is shoveled over the burning bomb simply to cut down its radiant heat; sand does not extinguish the bomb. Covered with sand, the bomb can be scooped up in a shovel and dropped into a metal pail in which several inches of sand has been placed. By running the handle of the shovel under the handle of the pail to protect the hands from the heat the sand smothered bomb can be carried from the premises and dumped where it will burn itself out harmlessly.

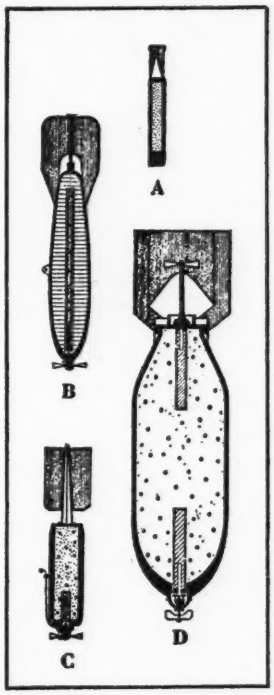


Fig. 1. These are the bombs to guard against. A. The 2-lb. magnesium-thermit incendiary. B. The 50 and 100-lb. oil bomb. C. The 30-lb. fragmentation bomb. D. The demolition bomb, 100 to 4000 lb.

To use this fire-fighting equipment with maximum efficiency industrial workers must understand its operation and they should be given some drill work. Aside from the maintenance of effective blackouts, this training in combatting incendiary bombs is about the most effective protection that can be given at the present time. It is not costly and even if no air raids ever take place in this country it still is good insurance against sabotage and ordinary accidental fires.

Tests by the War Department

Considerable study has been given to the character of damage done by bombs to various types of structures. As early as December, 1938, the War Department directed the Chief of Engineers of the U. S. Army to carry out a test program. Plans for shelters to give protection against splinters and those to protect against direct hits were prepared and in September, 1940, work was started on a site on Gunpowder Neck at the Aberdeen Proving Ground, Md. Detailed description of the structures and tests are given in a 55-p. report issued by the U. S. Office of Civilian Defense.

In the explosive bomb tests, a surprising amount of damage to concrete columns and beams was done by splinters. In one case all the concrete covering of a structure was knocked off and a considerable portion of the concrete inside the vertical column steel was damaged. To avoid this damage a protective brick covering was suggested.

A considerable amount of damage was observed as the result of earth shock. The footings of the buildings were moved laterally, or lifted up by the effect of bombs exploding in the ground nearby. This resulted in serious damage to the frames of the structures. Reports from abroad and the results of these limited tests indicate that a steel frame building, being more elastic, would suffer less damage from the direct effects of bombs than a concrete frame building. In either case, the structures should be designed as a continuous frame and in such a way that lateral movement of the footing or destruction of a column will cause minimum damage to the building as a whole.

The serious damage caused by bombs exploding underneath portions of the building prototypes showed clearly that the damage from confined explosion is a major problem in protective construction. In the case of the tests there were no walls to assist in confining the effects of the explosion of bombs, but the concrete slabs in some cases were completely torn loose from the beams. All were seriously damaged by the upward force. It was noted in particular that failures occurred in slabs and in beams where the bars were bent up to provide for a

Fig. 2. Smothering an incendiary bomb. Volunteer firemen at the Westinghouse East Pittsburgh works practice extinguishing an incendiary bomb with sand. Once a week the 225 volunteers hold drills, learning the exact moves they'd make if enemy bombers came—battling fire bombs with sand and water spray, unreeling hose and putting out various types of blazes started to give them practice

shear. This damage suggests the need for careful design of a structure which is to be subjected to bombing for the ordinary loads and for the explosive forces which may be applied underneath the floor slab. The use of straight bars without attempting to provide for shear by bending up bars at quarter-points is recommended.

With regard to the use of blast vents to reduce damage from explosion, the results of the tests would indicate that very little value can be expected from them.

The 5-ft. thick roof of a section of one type of bomb-proof shelter resisted the effect of the impact and explosion of 600-lb. bombs. However, no hits were made in the central portion of the slab, both hits being over the exterior wall. Some cracking in the wall directly underneath the point of impact was noticed. A 600-lb. bomb striking on the 2-ft. roof section of the shelter perforated the roof and exploded inside the upper gallery of the structure. The damage was severe, very heavy blast pressure resulting from the explosion. This damage emphasizes the need for an adequate roof for a structure designed to resist a direct hit. The failure of the concrete at the top of the side wall and the lack of mechanical connection of the steel emphasized the previously stated requirements that reinforcing steel should be welded or otherwise mechanically connected for greater effectiveness. Serious damage from earth shock was observed. Nearby hits caused an opening of the construction joints and cracking of the walls of the structure and in one case where a bomb detonated in direct contact with the 5½-ft. concrete wall, it spalled off about 2 ft. of concrete on the inside. This damage shows the urgent need of preventing a bomb from exploding in close contact with underground structures. Based on the limited information from these tests, it would appear desirable to place the structure on the surface of the ground, with a concrete apron to prevent bombs penetrating into the earth underneath. Another possibility, but one which would probably be more expensive, would be to use this type of structure and place a concrete burster slab at the ground level, extending out for a sufficient distance to prevent explosions close to the wall underground.

In regard to the effect of bombs on electric cable and underground pipe, the results obtained so far indicate that electric cable is quite resistant to the damage from near hits, and that screwed steel pipe will withstand the effects of earth shock very satisfactorily.

Since the problem of effective camouflage is one that is intimately related to the methods used in bombing, further aspects of bombing are covered in another article dealing with camouflage in this issue. The effects of bombing are also considered in the article on the effect of the war on English and Chinese power stations immediately following. All these matters of bombing and protection against bombing are more or less related and it is impossible to discuss one without reference to the other.

Until such time as we actually begin to experience enemy air raids, it is unwise to spend a great amount of effort in providing protection except in the case of military objectives of the most important character. While power plants come under this classification it will be well even here to display caution. The purpose of these articles is not so much to encourage the construction of these protective measures as it is to acquaint readers with the methods available in case protection really becomes necessary.

Table listing the probable effects of demolition bombs on certain specific installations

Objective	Bomb weight (pounds)	Fuse	Point to be attacked	Danger radius (feet)	Probable results
Airplane	100 300	Instantaneous	Area where planes located.	75 to 100. 100 to 125.	Serious structural damage.
Bridge, concrete reinforced and supported wholly by piers.	1,000	Delay	Piers and approach spans to bridge.	15	Displacement of piers and span. Collapse of one or more spans.
Buildings of steel, brick, and concrete, latest type of factories, warehouses, rail terminals (not sky scrapers).	100 300	do do	Building itself. do	Building itself. do	Penetrate floors, destroy walls and floors and cause serious fires.
Dams and spillways	2,000	do	Close to dam on water.	15	Should crack dam or cause hole, collapsing structure.
Railway tracks	100 300	Instantaneous	Center of single track. Rail centers over area.	7 9.	Should cut rails, tear up 20 feet of track. Cut rails and tear up 30 feet of roadway.
Subways	500 or 600	Delay	Above subway	15 either side	Penetrate, cave-in roof or walls.

Effect of the War on Foreign Power Systems

While we have been fortunate so far in keeping the enemy from our shores due almost entirely to our geographical position we cannot ignore the fact that he may come; with token air raids, if nothing more. To protect ourselves and our plants against undue damage from such raids it is to our advantage to know what the effect of bombing is on plants in foreign countries. The information upon which the following discussion is based came mostly from England and China. The bombardment of Shanghai was particularly severe and a careful study of the destruction to the power facilities there may help us in determining what to do in event of attack

IN PLANNING to protect our own power systems from air raid damage we naturally are interested in knowing how the severe bombing in England and in other foreign countries has affected the power stations in those places. While no great amount of information has reached us most reports seem to indicate that the damage has been remarkably small —superficial in most cases. As reported in the London Electric Review, in some instances damage to English power stations is looked upon rather more in the light of annoyance and a test of endurance than anything else. One plant had the turbine room roof blown off twice and the chief engineer in referring to it said that he would have to summon all his sense of humor to see the funny side of it if it were blown off again. "Still," he said, "the enemy comes along and blows the place up and you set to work to put it up again."

No detailed information is available at the present time in regard to the effect of the extremely heavy recent bombing of German industrial centers. Judging by the large scale of these operations it is quite probable that the damage to power stations in these centers is much more severe than that of the English stations, but until more detailed information is available our judgment must rest on the data that is available regarding English experiences.

Apparatus Pool

The restoration of damaged power facilities in England has been much simplified and expedited by the foresight shown in providing a pool of apparatus upon which damaged stations can call. At each plant, furthermore, plans are made to outline in advance exactly what will have to be done to each particular section of the plant in case damage occurs. With this system even the most serious destruction assumes a straightforward aspect and a great deal of wear and tear on the engineers responsible is avoided. In one instance where a high explosive bomb completely wrecked the switchhouse of a large generating station, with this well planned scheme of action, service was restored in less than 24 hr., despite a slight delay in the delivery of certain connecting equipment, part of the apparatus pool.

The equipment in the pool is only for emergency use, it is not intended for permanent installation. The amount of equipment kept in the pool is limited and when a piece of equipment is withdrawn from the pool it is important that it be returned to the pool at the earliest possible time.

In providing protection against damage it was evident quite early in the war that little could be done in protecting machinery against a direct bomb hit. Precautions were taken, therefore, to limit the extent of possible damage. Massive blastproof walls were erected around turbines and other important equipment. Narrow catwalks are provided to give easy access to the units and in some instances steel arched roofs were constructed, but experience soon showed that this type of roof added little to the protective qualities of the arrangement and it prevented the radiation of heat.

Aims in Providing Protection

The aim of the experts in providing protective measures has been the segregation of all individual machines. Blast and fireproof walls have been built between the important units so that if one machine was knocked out of service the remaining units would be unaffected.

In switching centers each piece of switchgear is isolated from its neighbors by fireproof walls and provision made to run off the oil in case of fire. Cable ends have been protected by brick and concrete walls, and oil stores protected in the same way.

The tremendous expense involved in all this protection has carried a 50 per cent government grant, although in the case of some installations a committee of the industry is empowered to recommend increases up to 100 per cent.

The protection of transformers by building sandbag walls around them from 2 to 3 ft. thick or double walls of sheeting filled with ash, has been found effective in preventing damage due to flying iron and splinters of all kinds.

Aside from the damage caused by flying debris from blasted buildings or road surfaces, considerable danger arises from the blasting of mud into the windings of machinery. The mud has a tendency to pack underneath the brush gear of rotating machines almost like granite and the windings and the end

risers become one solid mass. The necessary protection is easily afforded by means of shields.

Chinese Experience

In China, in the bombing of the Shanghai power stations, the experience parallels that of England. The most serious and widespread damage resulted from flying bomb fragments and from machine gun and rifle bullets. In a few cases effective protection against this type of damage was afforded by the use of barriers of timber, sheet metal or sandbags. In Shanghai, however, there was a shortage of such materials and so only a small percentage of the equipment could be protected.

As reported by Hunter and Young, the distribution engineer and superintendent of maintenance of the Shanghai Power Co., effective protection was afforded by the ordinary 10-in. brick walls of small substations and also by sandbags or barriers of timber or sheet metal placed over the windows. Almost invariably damage done to equipment in brick or concrete substations was caused by fragments or bullets penetrating unprotected windows, ventilators or other openings.

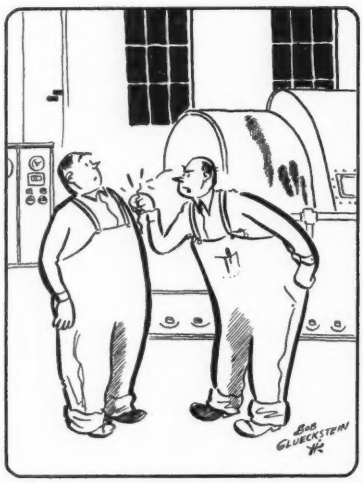
Reinforced concrete buildings stood up well against bombing and shelling in Shanghai. It was common experience to find substation buildings and their equipment practically unharmed within the confines of mills and factory areas that had been very badly damaged.

As reported in the May 16, 1942, Electrical World, of the 400 transformers totaling 300,000 kv-a. in the Shanghai area involved in the hostilities, 21,000 kv-a. or 7 per cent, were damaged; 19,190 kv-a. or 6.4 per cent, were restored to service after being repaired at the low cost of 2 Shanghai dollars, or about 40 ct. U. S., per kv-a. This left only 2000 kv-a. or 0.66 per cent which were damaged beyond economical repair and had to be scrapped. Ninety per cent of the transformers were therefore repaired and restored to service.

In England as in Shanghai, the modern brick-built substation seemed to withstand fire equally well as blast. In one instance the sole remaining building in the center of a wide devastated area was a brick substation. In the old types of building, damage appears to be limited to the destruction of wooden undersheeting and supporting members of slate roofs caused by sparks blown from burning adjacent buildings into crevices. The great thing is to prevent incendiaries from lodging in the roof or in the gear. For this reason it is recommended that besides enclosing the equipment wherever practicable the roofing should be as thin as possible. The incendiaries will then in most cases fall straight through the roof, glance off the gear if it is underneath and burn out harmlessly on the concrete floor. Steel switchboards have proved extremely effective.

Damage to Underground Distribution

The greatest amount of damage done by bombing has been to the underground electric distribution systems; this, naturally, would be expected. Experience has shown, however, that paper-insulated, lead-sheathed and armored cable stands up to the very severe damage, irrespective of voltage. In one case reported it was only the electric



"This blond hair wasn't on your overall BEFORE the blackout!"

cables which held up a damaged bridge. Many cases are on record where cables, depressed and twisted many feet below the laid level did not fail. Sometimes, though not always, it was found that the stretching of cables laid direct in the ground was confined to the length of the cable in the crater and did not extend appreciably any distance on either side. Frequently any slack in existence in adjoining manholes has been sufficient to prevent damage to the joints. Cables are usually pulled along the ducts toward the crater and the wipes of the joints are torn away from the lead sheath, often two and three manholes away from the crater. In some cases this pulling of cables in ducts extends for a considerable distance—300 or 400 yd.

In Shanghai, experience with regard to damage to underground cables paralleled that in England; the damage was relatively small. There were some 600 mi. of paper-insulated, lead-covered cable of all voltages up to 33 kv. in the affected area, all buried directly in the ground at a depth of approximately 3 ft. These cables were damaged by bombs at 26 locations. Most of the faults were easily repaired, however, and with little loss of time.

From the foregoing and from other reports which have reached this country from time to time it is evident that the effects of bombing and gunfire from the air upon modern fireproof generating stations is comparatively slight. What destruction is in the case of attacks such as made by the R.A.F. upon Cologne had not been disclosed, but previous reports from Germany bear out experience in England. An article in the German press in describing an attack upon a Dutch generating station stated that the station was "slightly damaged, but was able to operate". This station was evidently hit since the removal of a dud from the inside works was necessary.

Destruction in Warsaw

Large caliber artillery fire, on the other hand, has a much more destructive effect, compared with aerial bombing. Descriptions of the restoration of services in Warsaw after its occupation by the Germans in September, 1939, give considerable information regarding the effects of such fire. Although the Germans had bombed Warsaw heavily in connection with their general advance and during the siege, the damage to the power plant which they describe is specifically attributed to artillery fire. After 8 days of bombardment at least two turbogenerators had received direct hits and the remainder were damaged though not severely.

In many ways the damage wrought by aerial bombing is not as severe as might be expected. Certain types of peacetime disasters often do considerably more damage to utility plant and equipment in this country than seems likely from enemy action. An experience like the hurricane which struck New England several years ago should fit our repair crews well to combat the effect of any enemy bombing that we might expect.

Protection of Plants by Camouflage

The problems involved in the effective protection of power plants and other military objectives by camouflage or protective concealment as it is known in this country requires an intimate knowledge of bombing technique. It is for this reason that a considerable part of this article is devoted to a study of the methods used in modern bombing technique. Camouflage, properly done, provides a most effective form of protection, but as in the case of protection by barriers and bomb-proof structures caution should be used in the use of expensive camouflage arrangements until their necessity is warranted by actual, or reasonably certain aerial attacks

THERE are two entirely different aspects to the problem of plant protection in wartime. The first, that of providing suitable covering and the erection of barriers has already received consideration.[1] The second is that of disguising the plant so that it does not appear to be what it actually is; in other words, it involves the art of camouflage. Of the two forms of protection the latter is by far the most interesting from a scientific standpoint. Only little of it has been done in this country.

The purpose of camouflage is to make the bombing of a specific target as difficult as possible. In order to carry out accurate bombing of a target it is necessary to recognize it at a distance of several miles; if the target is not recognizable at this distance the bomber will miss the target if he drops his bombs; if he decides to make another run he will be detained in that area thus giving the local defense a greater opportunity of dealing with him; camouflage has then achieved its purpose.

The problem of camouflage must be approached gradually, however, and care taken not to overdo it. A rush to install elaborate camouflage schemes means diversion of materials, man-hours, and money that cannot be spared from war work. Hasty action, especially by self-styled experts, is likely to result in wasted effort on improper or totally unnecessary installations. All reliable authorities warn that in most cases plants should steer clear of complicated, expensive camouflage schemes and stick to simplicity. The things a bombardier looks for as he swings his bomb-sight into action are the very things a plant should watch for in planning concealment. In simplest terms they are distinctive form, shadow, surface texture, and —less important as bombers go higher—color. Water, tanks, chimneys, large coal piles, smoke from power plants, etc., are all things that are easily spotted from the air.

Mistakes in camouflage are easily made. Many readers will recall the camouflage applied to the large cooling towers at one of the large English power stations; these were disguised with painted trees. However well this camouflage may have been applied, the plan completely ignored the fact that no trees grew anywhere in the vicinity.

The problem of camouflage or "protective concealment" as it is technically known here, is intimately related to bombing methods. The most expedient form of attack

[1]Bombs and Bombing, page 60.

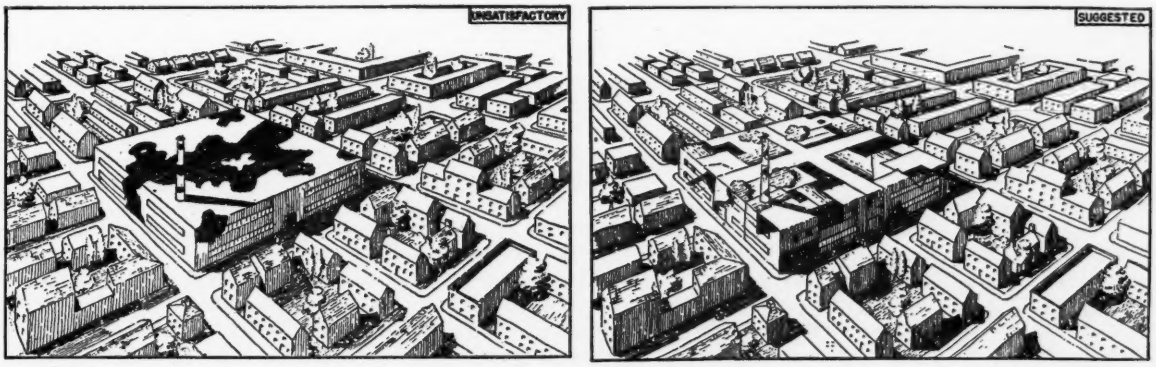


Fig. I. Use of patterns in an urban area
(a) Purely disruptive painting is worse than none if it serves only to draw attention (b) Although the illusion is imperfect, it is sufficient to greatly retard recognition from the air

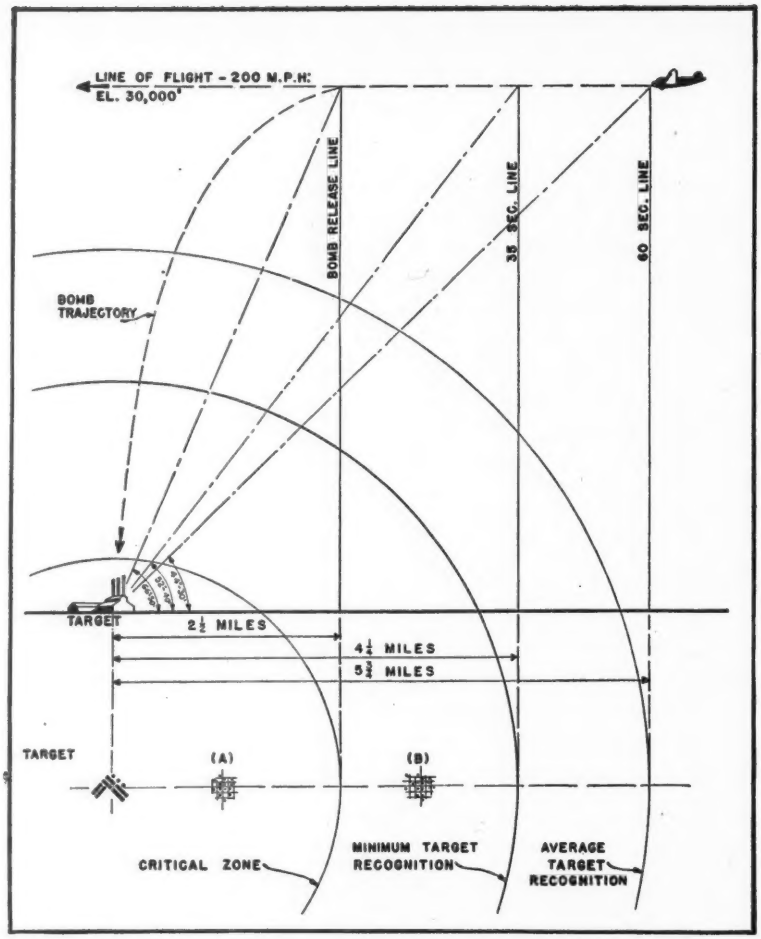


Fig. 2. Typical timing for precision bombing. The bombardier must see the target and have bomb-sight in operation at the 35 sec. line for precision bombing, or another approach must be made. Landmarks (A) within bomb release lines are helpful for area bombing of concealed target when position is plotted from previous information, and when line of flight passes directly over (A) landmarks (B) outside of critical zone are not so helpful for area bombing

for an enemy whose bases are likely to be at some distance from his objectives may well be precision bombing. Recent experience indicates that many daylight attacks are made at altitudes of from 18,000 to 30,000 ft. or more. The problem of flying a single bomber flying 200 m.p.h. at an elevation of 30,000 ft. is illustrated in Fig. 2. For higher speeds and lower altitudes the angle of view for the minimum recognition distance becomes smaller and more difficult.

Precision bombing is not possible unless the target can be seen by the bombardier. This means that well concealed installations cannot be attacked by precision methods. Dive bombing is utilized against vital concentrated targets such as central power plants, bridges or warships. The maximum diving angle is 70 deg. Planes assigned to such missions approach the general vicinity of the target at an altitude of about 15,000 ft. and quickly circle down to about 5000 ft. definitely locating the objective during this descent, but not staying over the point to be attacked. From this altitude the dive is started with the pilot simply keeping his sight on the target. The bomb is released at about 1400 ft., and the plane automatically pulls out of the dive. The plane levels off at about 800 ft. The pilot then has nothing to do but save his skin.

Low altitude bombing may be undertaken for the express purpose of destroying interceptor planes that are still on the ground, or for disrupting anti-aircraft defenses.

The use of intersecting radio beams, previously installed and placed in operation from points in friendly territory, may be appropriate on extremely extensive area targets that are strongly defended. Camouflage provides no protection against such forms of attack. Such attacks are made through solid overcasts with a minimum of interference from anti-aircraft or interceptor planes.

When a single bomber is enroute to attack a given objective, the bombardier begins to make a careful check of the ground speed at probably 40 or 50 mi. from the target. After careful checking of the ground track, the bombardier instructs the pilot to correct the course to the "collision" course. The forward horizon is now constantly scanned for landmarks. As illustrated in Fig. 3, the ensuing actions of the bombardier might be as follows:

He spots the tank farm on the right front and checks his approach position with respect to it. Possibly that section of the river running north will aid him in checking his ground track. Reaching point B he easily picks up his location by sighting up the Green River where he definitely spots two bridges and the town of Adams. Brown is to his right. He checks the ground track and gives the pilot any changes necessary. He then estimates the time needed to reach the critical line and notifies the pilot accordingly.

Now he searches the horizon to pick up the objective. At this point the value of camouflage becomes effective because it is here that he must definitely identify it or miss his chance of bombing it. Assuming that it is not properly concealed, as the plane crosses the river the bombardier locates and positively identifies the objective, notifying the pilot by radio interphone of the estimated time to the critical line. He then trains the telescope sight on the target, makes presettings on the bomb-sight, and opens the bomb bay doors. After this, he checks to see that the bombs will be dropped "armed."

If the approach meets with no opposition the bombardier will set bomb-sight gyros in operation at least 15 sec. before reaching the critical line and will warn the pilot, who thereupon makes every effort to fly straight and level. The pilot directional indicator which is directly synchronized with the telescope of the bomb-sight, will tell him if he is on the course, left, or right. Any small changes in directions are now made by flat skidding turns to maintain an even keel.

Since the mission calls for accurately placing demolition bombs on a certain building, it is a precision bombing problem. When the bomb release line is reached the bombs are automatically dropped, probably in salvo since it is a concentrated target.

The foregoing brief description of the technique used in bombing is given to provide a better understanding of the requirements of protective concealment. Although photographic reconnaissance may permit an enemy to confirm the exact location of objections, bombardiers must still recognize their targets and direct their bombsights hastily by eye.

Elements of Visibility

Landmarks define a region, but within the region the target is distinguished by such elements as its form, shadow, surface texture, and color. Forms identify structures; shadows emphasize the forms and are frequently more visible than the object sought. The texture of a surface affects its brightness and establishes a sensitive distinction between bodies. Colors, on the other hand, fade with an increase of the viewer's altitude, and minor differences are lost to sight.

Site Selection

In general new installations should be planned for full concealment at the start. This implies the selection of a favorable site as well as the careful design of the installation itself. Proper site selection permits adequate dispersion and allows a considerable amount of camouflage to be "built in" by a salvage of natural surroundings.

Dispersion is of dominant importance. On the one hand it simplifies concealment, and on the other, even totally without concealment, it reduces the concentration of damage from any given attack.

Rural areas have certain advantages over urban areas because misses cause little damage, because lower land costs permit greater dispersion, and because natural surroundings present a more innocent environment to imitate. Heavily wooded regions and landscapes broken with hills, ridges, fence lines, rocky outcrops, or hedges afford many features that facilitate the concealment of structural elements. Aside from the use of smoke and fog, the techniques available in such rural areas may be summarized as—

a. Hiding in woods, or in brushy, mottled ground.

b. Extending natural hills or cliffs over structures by means of dummies, or earth, or other artificial cover.

c. Disguising structures to resemble natural building groups in the vicinity.

d. Underground construction. In cities, disguise must normally rest upon the imitation of local building forms. The site, either for the rural or urban areas, should be chosen for its adaptability to the prevailing patterns.

A primary consideration in the selection of a site should be the avoidance of landmarks that might serve the bombardier as convenient references for alinement. Any prominent feature such as a gas holder, stream junction, peninsula, or highway intersection is a hazard.

Degrees of Concealment

Concealment, or the reduction of visibility, is evidently a relative matter influenced by weather, seasons, the time of day, and the methods of observation available to the enemy. Concealment measures may range from the simple use of dull paints on otherwise bright surfaces to elaborate landscaping or underground work.

For existing installations the simplest treatment to reduce visibility may be the mere suppression of bright colors or sharp contrasts with uniform dull coatings.

"Second stage" concealment plans for existing units may involve the introduction of patterns designed to resemble the charac-

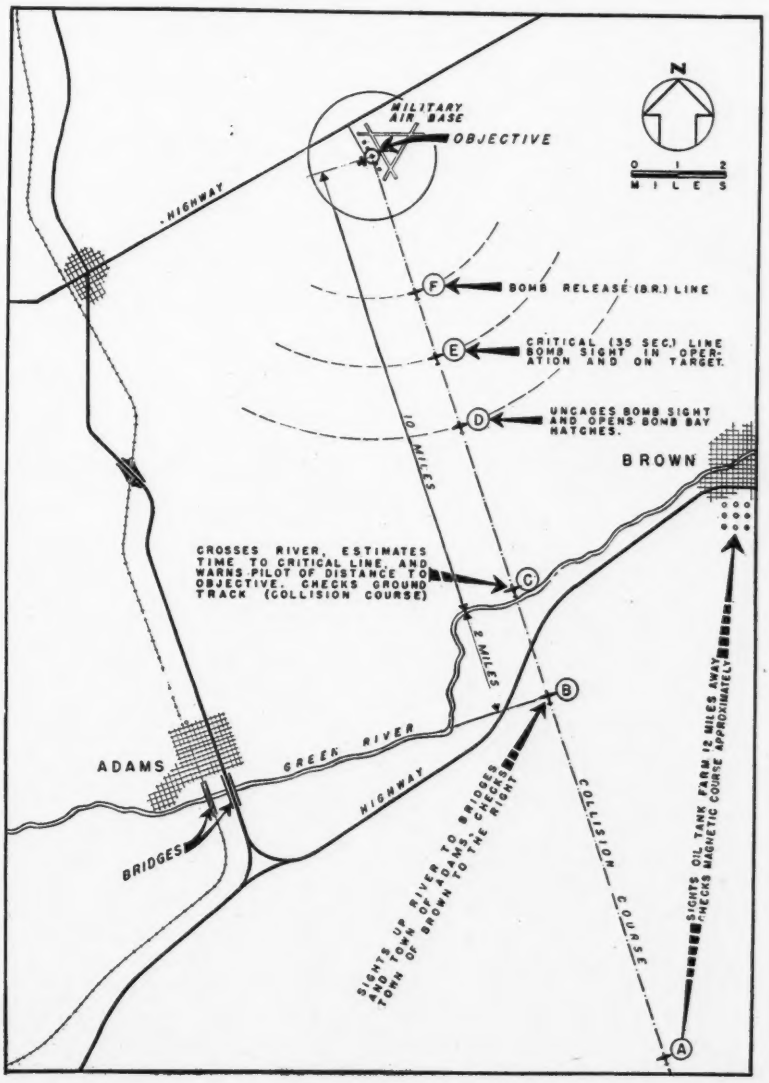
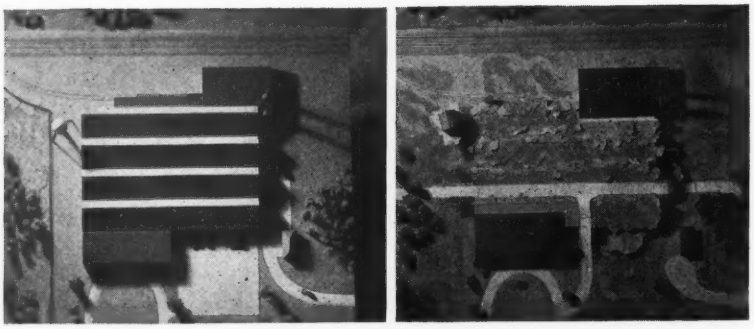
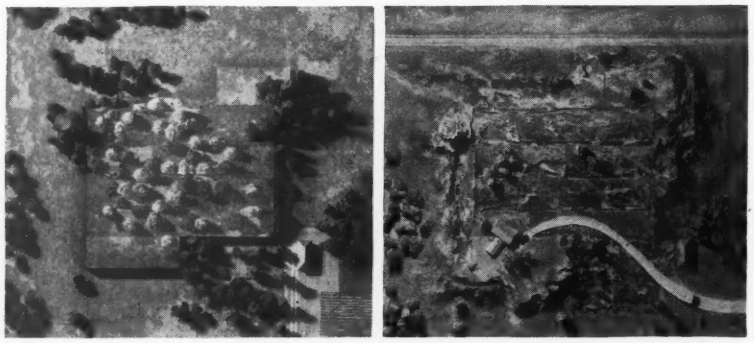


Fig. 3. Typical bombing problem



Figs. 4 and 5. Partial concealment is shown by camouflage treatment of model (left) with use of flat, irregular shapes to make one building seem to be two (right). This study is one of many by General Motors' Styling Section which has been converted to "Camouflage and War Service Section." This plant has the typical identifying marks, such as: high water tank, high smoke stacks, railroad siding, and parking area, which are all extremely revealing from the air. The following models show the same plant employing each of the succeeding types of camouflage: 1. Color resemblance and transplanting. 2. Color resemblance and dispersal illusion. 3. Color resemblance and disruption. 4. Pattern resemblance



Figs. 6 and 7. Total concealment experiments. Trees painted on roof conform with foliage near the plant (left); an all-out scheme using many techniques (right). Such elaborate methods could be justified for very few plants. For most, inexpensive and simple camouflage ideas are best

teristic patterns of the region. This may not entail any additional cost except the slight amount involved in laying out the patterns and in preparing the plans. For example, in an urban environment, if there is a building with an extensive flat roof, much is gained by painting imitation streets across it. In the country, however, appropriate patterns would resemble wooded areas or cultivated ground.

More deliberate or "third stage" camouflage plans may involve screening and the introduction of false forms to destroy revealing outlines. Salvaged lumber, common chicken wire, cheap textiles, nets, and wire guys can be combined in various ways to hide shadows or to resemble small buildings, structural elements, and even trees, if trees exist in the neighborhood. In a vicinity that contains other natural growth, shrubs and vines may be used to great advantage in breaking angular outlines and "absorbing" shadows. Flat surface textures can be roughened with crushed rock gravel, sand, and other ordinary roofing granules, with colors introduced if desired.

Aids to Concealment

Dummy or decoy installations may serve either (a) to draw bombs away from an essential plant whose concealment is not absolutely secure, (b) to dilute enemy fire by offering more targets than are actually occupied, (c) to deceive the enemy with respect to the volume of production or the region under development, or (d) to delay and confuse the enemy bombardiers, reducing the effectiveness of their fire and affording more time for defending aircraft to go into action. In some cases, the decoy will be more plausible if it appears to be revealed only through accidental defect in its concealment. However, during the early stages of a conflict or in an area where relatively few industrial plants of any kind have received camouflage treatment, a completely unconcealed dummy may be equally plausible. To be safe dummies should be from a half to three quarters of a mile or more distant from any vulnerable points.

Smoke, and artificial fog are measures that may have considerable application, particularly for existing structures so large, so conspicuous, or so well referenced that they cannot be adequately concealed in any other way. Reports from various sources, including British, have been rendered on the height at which fogs will lie or the amount of wind which they are able to withstand in any reasonably efficient manner. It is certain that a complete fog-out by means of artificial haze would be extremely difficult to obtain. However, even the amount of haze which is normally produced over a region about a soft coal burning city such as Pittsburgh on a moderately still day will materially aid the concealment of large installations by camouflage. The combination of artificial fog and camouflage is, therefore, one to be sought.

Smoke- or fog-generating equipment may be permanently distributed on all sides of an installation, or it may be arranged in portable units that can be moved to windward as required.

Counter illumination is a measure that has been proposed for either (a) the obliteration of shadow, or (b) blinding or confusing the bombardier at night. Because of the great intensity of illumination needed to match sunlight—in the order of 10,000 footcandles requiring about 1000 w. per sq. ft., costs for the former use are likely to be prohibitive. For the latter use, experimental developments do not yet promise success.

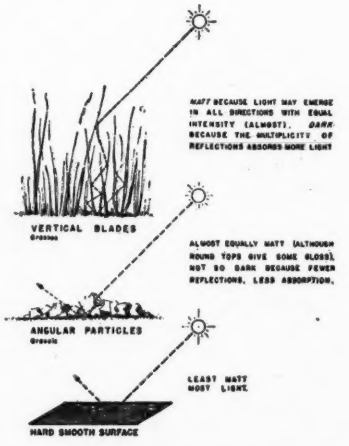


Fig. 8. Influence of surface texture

Blackout Materials and Window Protection

Facts regarding the use of blackout paints and luminescent materials as well as anti-scatter treatment for glass. The widespread use of blackout paint is to be avoided where other, more effective methods are available. Luminous sheet materials are preferred over the use of luminous paints where this type of protection is felt necessary. Various methods are described for preventing glass from shattering due to explosive blasts

MUCH HAS BEEN written during the past year concerning the use of paints and other materials used in blacking out buildings, but not all of what has been written has been effective in establishing uniform methods or plans of procedure in blackout technique. After Pearl Harbor there was a frantic rush to black out anything and everything—factories, homes, hospitals, power plants, etc., and for a while much black paint was used up rather uselessly and ineffectively. The writer recalls seeing a photograph showing a painter painting the windows of Grand Coulee Dam power house, from the *inside!* It is generally known now, as it was then, that painting windows from the inside causes reflecting surfaces that are often more visible than the lighted windows themselves.

Based on experience in England, it is, of course, well known that blackout, camouflage, shatterproof and luminescent paints all have certain amounts of usefulness in modern warfare as it affects civilians, but to what extent these paints will be necessary in this country we do not know. Blackout paint and other related materials have their proper use in this country as well as in England for we *are* at war, but before launching on any large-scale blackout program it may be well first to get the opinion or advice of the Office of Civilian Defense or the War or Navy Department on the question, and above all, use a little common sense.

The idea of painting windows black is simple, but it probably is too simple for most cases. Shields are more effective than paint. More effort is involved to make them but, once made, they can be put in place or removed at will.

There is, moreover, a realistic danger of large windows breaking due to heat, if they have been coated with black paint. This more often than not happens when a portion of the window is struck by direct sunlight while the remainder is shaded. Of course, tan, dark brown, and olive drab paints can be used with increased safety in this respect. The uses of paint to achieve blackout, however, are definitely limited. There are other cheaper and better methods, particularly the use of shields already mentioned. Such shields, built of inexpensive composition material mounted on light window frames can be constructed to fit snugly into the window casement from the inside. The perimeter of the shields can be covered with something similar to window stripping to insure snugness and prevent light leakage.

The advantage of shields over paints is obvious. While a concussion results in flying glass, shielded windows should to a considerable, if not to a complete extent, eliminate such danger. Shields will be blown inward on the floor and may be reinserted in the window, thus attaining blackout again

"I figure you could tie him in the boiler room — then you would always be able to locate it in the blackest blackout."

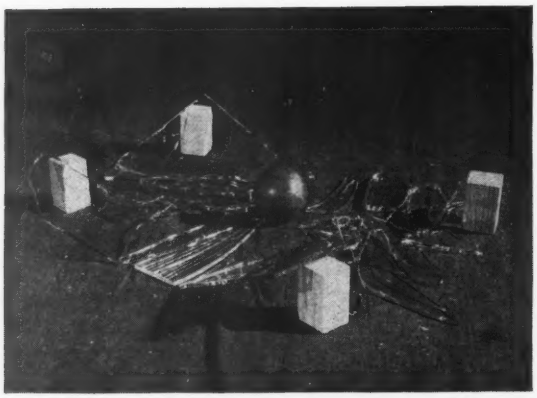


Fig. 1. Showing the use of "Shatterbond." Here a 2-lb. lead ball, falling from a height of 2 ft. shattered this pane of uncoated glass into jagged razor-edged fragments. Photographs furnished by courtesy of The Wilbur & Williams Co.

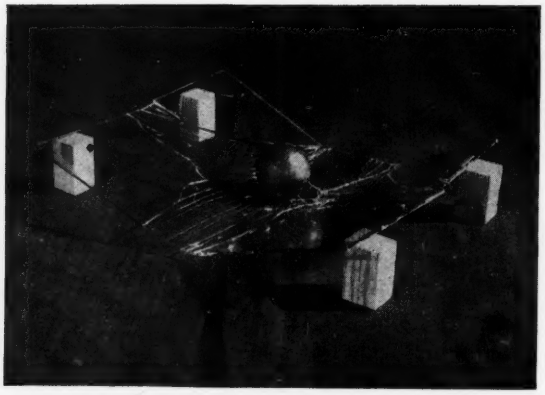


Fig. 2. Showing the effect of the same 2-lb. ball, falling the same distance on a pane of glass coated with "Shatterbond." The glass is shattered, but note that the small fragments are held together by the tough, elastic, transparent coating

where this would be impossible relying on painted glass alone; also the plant interior would be protected from the elements.

Despite the advantages of using shields, there are undoubtedly many cases where the use of blackout paint is advisable—where it provides the simplest and most inexpensive method of blacking out windows. Such cases include rooms or buildings used as storehouses, places not usually occupied by many people.

The colors most effective for such paints are black, dark brown, and olive drab. Such paints should dry with a flat finish and should "cover" in one coat. Several paints for this purpose are available, designed for use inside and outside on window glass. Their usage should be confined to glass only. The black dries in about 10 hr. and the other colors in approximately 6 hr. Their adhesion to glass is very good and they do not contain any ingredients that will cause "bleeding" when the time comes to clean the windows and repaint.

As already mentioned black paint applied to large plate glass windows is known to have caused cracking of those windows due to the absorption of heat by the paint, but the risk of cracking ordinary window glass is small, due to the fact that the panes are not large. Naturally this hazard is reduced materially in the use of other colors of blackout paint. It is not always necessary to use black and either the dark brown or olive drab may be used with much less risk of subsequent cracking.

The application of paint to the interior of glass is lowest in initial cost because expensive scaffolding is usually not necessary. The most serious disadvantage of this method lies in the creation of a mirror-like effect on the exterior as moonlight, flares or searchlights are more sharply reflected than by uncoated glass. Interior application, therefore, can be considered as a partial blackout only. It is suitable in courts, light wells, etc., where surrounding walls of buildings act somewhat as a screen, but would not be considered adequate for exposed areas.

The coating of the exterior of the glass with blackout paint, where paint is selected as an obscuring medium, prevents light from showing through and eliminates glare. Such coatings must be reasonably durable, should dry with a flat finish, hide in one coat and be readily removed when the necessity for blackouts has passed. Several paints meeting these requirements are available and are recommended by the Office of Civilian Defense.

The question has been raised from time to time, that in order to get maximum light reflection on the interior of blackout windows, a white undercoat might be used on the exterior glass under the blackout paint. While this may seem quite logical, preliminary laboratory tests indicate that in a majority of cases there would not be sufficient light reflection to make it worth while to expend extra labor and materials in the application of this undercoat.

Anti-scatter Treatment for Glass

Flying glass is one of the most serious causes of air-raid injuries; and shattered windows normally cause damage to equipment and valuable products.

To prevent the shattering of glass due to explosive blasts various methods have been devised to reduce this danger. One of the simplest used at first was the application of strips of surgical tape to panes of glass, but early last January the War Production Board issued a release requesting that surgical tape not be used for this purpose. The reason, of course, is obvious; surgical tape is far too valuable a commodity to be used for strengthening window glass, since it has more important medical uses. Various other methods are more effective than the use of surgical tape.

Several methods make use of sheets of material cemented to the glass with an adhesive or a liquid material applied with a spray or brush. It should be distinctly understood that these treatments will prevent glass from flying in splinters but cannot be relied upon to prevent breakage. They will often reduce extensive breakage by distant blast effects.

In selecting a window treatment to reduce the effect of splintering, the following should be considered:

(1) Tensile strength or extensibility.

(2) The material should adhere strongly to the glass.

(3) Both material and adhesive should retain their properties for a reasonable time under exposure.

The material applied to the inside of the glass may be in sheets or in strips.

The following material may be considered for use on glass:

(1) Paper—Papers that are thick and tough are preferable to thin paper. Papers reinforced with a mesh of cotton, linen, hemp, or other fiber are superior to other types. It is important that the adhesive should remain tacky and not become brittle after being applied. Suitable adhesives are ordinary flour paste or paper-hangers' paste with 5 per cent of glycerin

or molasses added, or gum arabic with 5 per cent of glycerin added.

(2) Cardboard—Where permanent obscuration is permissible an all-over covering of cardboard will be satisfactory. Adhesives may be one of those used for paper but should be stronger.

(3) Textile materials—Textile materials used as an all-over coating consist of two types: Those which give permanent obscuration and those which admit a certain amount of light. The former may consist of burlap pressed into a bituminous emulsion painted all over the glass. Where the admission of a certain amount of light is desired, textile materials may be used in strips on the inside of the glass and spaced not more than 6 in. each way.

(4) Transparent wrapping films—Materials of this type usually admit a large proportion of light but are not generally as resistant to splintering as the textile materials when the latter are properly applied. Some transparent fillers, however, are reinforced with fabric mesh which improves their strength. There are three principal types of this material which are obtainable.

(a) Cellulose nitrate film, known as "celluloid" which is reasonably strong but not recommended due to its inflammable properties.

(b) Cellulose film, consisting of two types, "coated" or moisture proof, which should not be used, and "uncoated." The uncoated is satisfactory and can be detected by moistening when it curls and softens slightly. It burns like newspaper when set on fire. Suitable adhesives are clear gum with 15 per cent of glycerin added, and gelatin or gum arabic dissolved in hot water with 15 per cent of glycerin added.

(c) Cellulose acetate film—This material does not take fire and in burning, melts and drops. Gum is not suitable for application. If an adhesive is not recommended by the manufacturer, a mixture of 9 parts of molasses and 1 of warm water may be used. Where the glass has been fractured or dislodged, a cellulose acetate film, reinforced with fine wire mesh, will provide a translucent flexible substitute material for glass.

6. Liquid coatings—Many varieties of composition are available for window coatings, some of which are transparent and others which have colored pigment to give obscuration. Flexible glues such as "bookbinders' glue" may be used, but a number of commercial coatings also are available. The effect of one of these, "Shatterbond," made by the Wilbur and Williams Co. of Boston is shown in Figs. 1 and 2. This material can be brushed or sprayed on the glass. The following claims are made for it by the manufacturers: 1. It transforms ordinary glass into a safety glass. 2. It dries in a few minutes and can be used on the inside or outside or both. 3. Exceptional adhesion to the glass —tensile strength 3000 to 5000 psi —highly flexible. 4. Is non-yellowing and resistant to abrasion. 5. Is inexpensive—average cost for a 5 by 3 ft. window 10 to 20 ct. 6. Is also available in various colors including black.

Many compositions include rubber as an ingredient, but only those compositions containing vulcanizing ingredients are likely to have desirable qualities.

It is impossible to predict the probable effective life of these coatings under various conditions. When evidence of deterioration occurs the old coating should be removed and replaced.

Luminescent Paints and Materials

Various luminous paints and sheet material are available to provide a small amount of light during blackouts. These materials enable people to find their way about during blackouts or locate quickly important facilities and objects. While they differ considerably in their chemical make-up, most of these materials behave similarly. After brief exposure to daylight or strong artificial light, they glow in darkness for several hours and can be seen easily; yet they do not throw off light rays and, therefore, are not visible from the air in bombing raids.

These materials serve two broad purposes. Small strips of certain types can be placed on any object making them easy to find even in pitch darkness. Other types can be made into directional signs and the lettering will be very clear against the luminous background.

For general use, the luminous sheeting is simpler to use than the luminous paints. Such material comes in sheets or rolls and it can be cut to fit whatever the requirements may be. In no sense must these products be considered a complete answer to all blackout lighting problems. They do, however, cause certain objects to become visible when the lights go out and for that reason they are very useful. Some of these luminous sheet materials have been used for many years in making advertising posters and to produce unusual stage lighting effects.

Luminescent materials are of two classes, fluorescent materials and phosphorescent materials. The first, fluorescent materials, glow only during the time they are exposed to the harmless and invisible

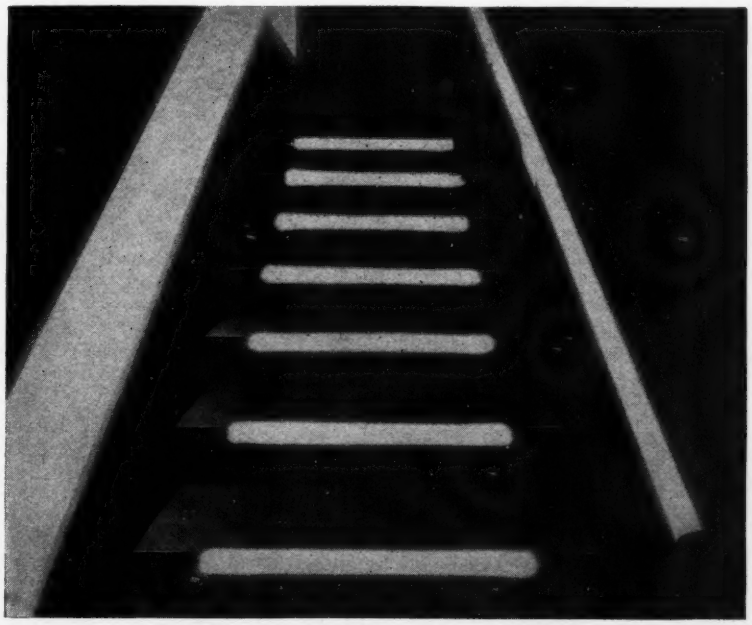


Fig. 3. A photograph taken in the dark showing the use of "Conti-Glo" P-10, a luminous sheet material made by the Continental Lithograph Corp.

near ultraviolet radiations now commonly referred to as black light. These are most advantageous for the solution of many problems of seeing in the blackout, for they may be turned on or off at will by simple control of the source of invisible black light radiations used for their activation. A good deal of time will elapse, however, before black light equipment in all the forms desired can be made available on the wide scale necessary. A disadvantage of their use is the fact that they would be useless in times of emergency when the power supply might be cut off.

Much more common, and more useful at the present time are the phosphorescent materials which glow in darkness following activation by exposure to visible light. Such materials are sometimes described as being capable of "storing" light and releasing it in darkness. Wall and ceiling panels of these materials properly arranged and activated, emit sufficient light for emergency illumination of rooms, corridors and stairways.

The use of these luminous materials has been suggested on control boards and control knobs and levers of important equipment in power stations and industrial plants. To a certain extent such applications might prove useful, but all these materials attain maximum luminescence only in complete darkness and this is a condition that is not likely to prevail in important plants even during blackout. After all, there is little danger from ordinary lighting or shielded lights in the interior of a plant which itself is adequately blacked out by means of covered windows or skylights. Luminescent materials can, however, be of value in the identification of machines and passageways around machines so as to prevent accidents during blackout periods.

While phosphorescent paints are available, care should be used in selecting them as they are sometimes difficult to apply and not always as satisfactory as luminous sheet material. Even the manufacturers of these paints advocate the use of prepared sheet material wherever possible. Quoting from the advertising literature of one concern that makes both sheet and paint—"accordingly we urge that those interested in phosphorescense use their ingenuity not in solving the problems of *building* a light source, but instead of devising ways and means for utilizing the factory built completely fabricated luminous sheets for their particular application. If the problem, for example, is to render a door knob visible in darkness, why spend hours covering it with undercoat, heavy applications of luminous paint and protective overcoatings? Why not take 5 min. to cement a piece of luminous sheet on the door *behind* the knob? Here the knob will show up in silhouette against the luminous ground and the luminous area will be washable, stable, of maximum brightness and not subject to wear.

The technical aspects of luminous materials, their composition and characteristics are necessarily complex and an understanding of them is not needed in their application, but a few facts may be of interest.

Classes of Phosphorescent Coating

Phosphorescent coatings for example fall into two general classifications, the Type A which have a high brightness during the first few minutes after excitation ceases and whose useful afterglow is relatively short, usually 2 hr. or less, and, Type B, characterized by a relatively low brightness shortly after excitation ceases but has a long afterglow, usually 10 to 12 hr.

Type A phosphorescent pigments in most common use are zinc sulfide or zinc and cadmium sulfides, and the Type B are calcium sulfide, strontium sulfide or combinations of the two. All phosphorescent pigments are relatively coarse in particle size since their phosphorescence depends upon a coarse, crystalline structure. They cannot be ground on a tightly-set roller mill or a stone mill without a serious loss in their phosphorescent efficiency. They are best incorporated in vehicles by stirring, mixing, or on a very loosely set roller mill. The range of phosphorescent colors is relatively small, Type A pigments usually having a green, yellow or orange phosphorescence, and Type B a violet blue or bluish green phosphorescence. The color of the materials in visible light is a dull white, with a grayish or yellowish tinge. Because of their extreme coarseness, phosphorescent coatings do not have very high hiding or whitening power, and occasionally white pigments such as titanium oxide, lithopone, or zinc sulfide are blended with them to supplement these characteristics. At times tinting pigments or dyes are added to modify their color in visible light or their phosphorescent color. Inert extenders may be added to improve the physical properties of the liquid paint. Such additions should be avoided if at all possible, since they tend to decrease phosphorescence. Because of their extreme coarseness, all phosphorescent pigments have poor gloss characteristics, and a marked tendendcy toward settling.

Type A pigments behave in paint vehicles in a manner similar to lithopone and zinc sulfide. Type B pigments are quite reactive and are also extremely sensitive to moisture, which destroys phosphorescence. They must be stored in moisture-proof containers and must be used in coating compositions in such a way as to be protected from moisture. Under some conditions of exterior exposure in certain vehicles, there is a tendency for Type A pigments to darken with accompanying loss of phosphorescence. From the standpoint of toxicity, these phosphorescent pigments are no more hazardous than other pigments regularly used in paints. It must be emphasized that this report does not apply to radioactive materials.

It is difficult to make phosphorescent coatings comparable in appearance to ordinary paints because of the coarseness of the pigments, and the lack of color range both in phosphorescent and in visible light. Paints made with these pigments have poor glow; also rapid and hard settling. The Type B pigments must be protected from moisture by a clear film of vehicle, or a layer of glass or other transparent covering.

Phosphorescent coatings are used because of their afterglow. However, the intensity of this afterglow is quite low and its duration is limited, so that the coatings are not always so useful as is desired. The intensity of the afterglow, immediately after activation ceases, is between 1 and 10 per cent of the fluorescent intensity during activation. Phosphorescent coatings are therefore useful only under conditions of extreme darkness and can generally be detected only when the eye has become adapted to the darkness.

Phosphorescent coatings generally require an appreciable time of activation to come up to full intensity. In the case of Type A materials this time may be from 10 sec. to 1 min., and for Type B materials from 1 to 10 min., depending on the intensity of the light source.

Maintenance of Protective Lighting

Protective lighting belongs to a phase of plant protection that is somewhat apart from the classes of plant protection considered in the other articles in this section, but since it is part of the whole system of plant protection this consideration of the maintenance of protective lighting systems is presented here. Modern protective lighting systems represent a substantial investment and it is quite as important to maintain them properly as it is to maintain any other expensive equipment used on a power system

by George A. Eddy, **Lighting Division, General Electric Company**

SECRET AGENTS of the Axis —with wire cutters in their pockets, dynamite in their satchels and murder in their hearts—are not the worst enemies of protective lighting systems. Actually, if the effectiveness of a protective lighting system is broken down, it will most likely be the combined effect of commonplace hazards to which all outdoor lighting systems are exposed—dirt and bugs, burned out and blackened lamps, circuit failures, and deterioration through exposure.

When you consider that an accumulation of dirt and bugs within a luminaire may absorb 50 per cent or more of the light generated, that one or two burned out lamps may darken the stretch of fence so as to necessitate a man standing by that location all night long, that a circuit failure may plunge a whole area into darkness and require hours or days to locate and repair, that excessive corrosion may require the purchase of considerable quantities of renewal parts the purchase and installation cost of which might readily be saved—then it becomes obvious that some maintenance is necessary. Actually, a modern protective lighting system represents a substantial investment and involves a good deal of high performance equipment which, in its own way, is as efficient as a modern aircraft engine. Such a lighting system deserves reasonable maintenance, as a safeguard of the investment. Such maintenance will not prove to be unduly burdensome or unduly expensive if done systematically—in fact, a systematic maintenance program will undoubtedly keep the system in better condition at less cost than is possible in any haphazard scheme of keeping the system going.

Let us consider some of the possibilities for obtaining these desirable results.

Group Replacement of Lamps Recommended

After the first few hundred hours, a protective lighting system will have a lamp out somewhere quite frequently if lamps are operated to burnout. In addition to involving a good many miles of travel for the replacement of these lamps, there is a serious loss of protection where the burnout occurs. Also it should be recognized that some lamps outlive their usefulness; their light output decreases through filament evaporation and bulb blackening to a point where they should be replaced.

A practical answer to this is group replacement of lamps. According to this practice, lamps are

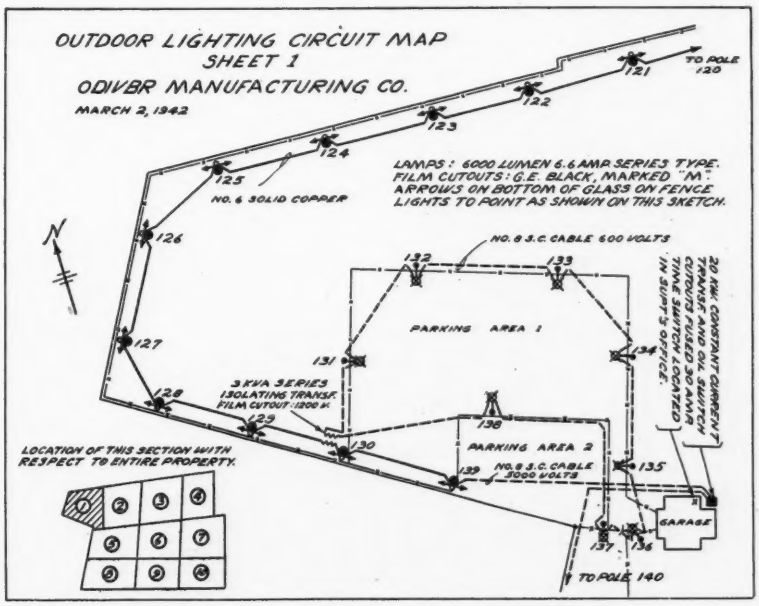


Fig. 1. Typical circuit map. Showing the layout of a manufacturing establishment protected by a modern protective lighting system. The pole numbers correspond to the numbers on the work report shown in Fig. 2

replaced throughout the system periodically, according to a schedule. All used lamps are brought into the shop for examination, and any considered suitable for further use are set aside for replacements of the early burnouts in the group just installed and for use in less vital and more easily accessible circuits.

The interval between group replacements is determined, first, by the type of lamp used; second, by the actual burning hours per night or per week; and third, by the per cent lamp outages one is willing to tolerate. Any type of lamp can be group-replaced, but since it is usually true that the cost of replacing a lamp exceeds the value of the lamp, usually it works out to be economical to use the so-called group-replacement type of lamp, which is expressly designed for about 50 per cent greater life than ordinary lamps, at the expense of a small increase in lamp wattage.

Obviously, there is considerable variation in the burning hours seasonally, which the replacement schedule will have to take into account. The date on which the replacement should be made can be calculated closely enough, or time meters can be connected to the circuits to show the actual burning hours.

Even with group replacements, there are likely to be some failures before the next replacement date. Total burning hours between replacements should be set so that the premature failures do not exceed about 10 per cent of the lamps in service. A smaller figure can be set if a somewhat greater lamp cost can be tolerated; or it may be worthwhile to allow different tolerances for different circuits, depending upon their remoteness.

WORK REPORT

OUTDOOR LIGHTING SYSTEM MAINTENANCE AND REPAIR

DATE: 5/28/42 SERVICE CREW: Hallman (IN CHARGE), Bond Edwards

POLE NO.	LAMP		FILM CUTOUT		CLEAN AND PAINT			GLASSWARE				INSULATORS				GASKETS				SOCKETS, RECEPTACLES				WIRING			FOCUS AND POSITION			REMARKS
	OK	REPLACED	OK	REPLACED	WIPED	WASHED	PAINTED	OK	DAMAGED; REPLACED	DAMAGED; NOT REPLACED		OK	DAMAGED; REPLACED	DAMAGED; NOT REPLACED		OK	DAMAGED; REPLACED	DAMAGED; NOT REPLACED		OK	DAMAGED; REPLACED	DAMAGED; NOT REPLACED		OK	DAMAGED; REPAIRED	DAMAGED; NOT REPAIRED	OK	READJUSTED	NEEDS ADJUSTMENT	STATE ANY UNUSUAL CONDITION OBSERVED; REASON NEEDED REPAIRS NOT MADE; OTHER WORK DONE; ETC.
136		✓	✓		✓			✓				✓				✓				✓				✓			✓			
137		✓	✓		✓			✓				✓				✓				✓				✓			✓			
138		✓	✓		✓			✓				✓				✓				✓				✓			✓			
139		✓	✓		✓			✓				✓				✓				✓				✓			✓			
140		✓	✓		✓			✓				✓				✓				✓					x		✓			Loose at terminal, tightened.
141		✓	✓		✓			✓				✓				✓				✓				✓			✓			
142		✓	✓		✓			✓				✓				✓				✓				✓			✓			
143		✓	✓		✓			✓				✓				✓				✓				✓			✓			
144		✓	✓		✓			✓				✓				✓				✓				✓			✓			
145		✓	✓		✓			✓				✓				✓				✓				✓			✓			
146		✓	✓		✓			✓				✓				✓				✓				✓			✓			
147		✓	✓		✓			✓				✓				✓				✓				✓			✓			
148		✓	✓		✓			✓				✓				✓				✓				✓			✓			
149		✓	✓		✓			✓				✓				✓				✓				✓			✓			

Fig. 2. Typical work report form

Incandescent lamps have a rated average laboratory life, and it is suggested that three-quarters of the laboratory life rating be taken initially as the burning hours between group replacements. This can be adjusted as experience is obtained.

Not only is it possible to make important savings in labor, tires, and gasoline through group replacements, but the method sets up a service schedule on which routine inspection and maintenance can be superimposed. Group replacement of lamps, therefore, becomes the most important basic step in setting up a systematic maintenance system.

When group replacements of lamps are made, examine each luminaire for the following:

1. Internal and external cleanliness.
2. Condition of glassware; replace any found cracked or broken.
3. Condition of insulators; replace any found damaged.
4. Condition of gaskets; repair or replace any found defective.
5. Condition of sockets and receptacles; replace any found burned or broken.
6. Condition of wiring; tighten or repair any found faulty.
7. Lamp focus and luminaire position; readjust if necessary.

It is a simple matter to check the luminaire on all these counts whenever a lamp is replaced. In fact, starting with good equipment, it should be true that the

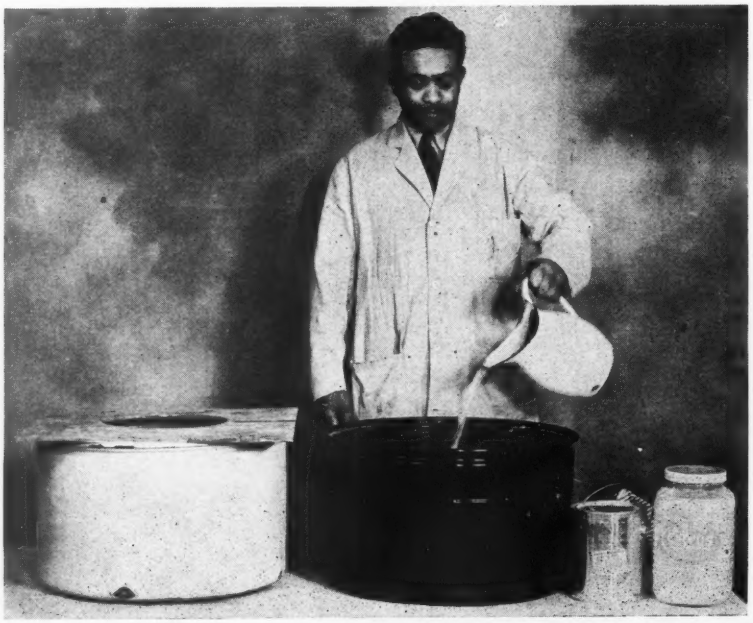


Fig. 3. All the materials needed to clean luminaires. 1, two tubs; 2, a highly soluble neutral soap; 3, a board to cover soap solution tub with a circular hole about 10 in. in diameter; 4, D-50R1 Novalux or comparable cleaner for Alzak aluminum; 5, several soft cloths

maintenance work to be done at the time of lamp replacements amounts to little or nothing more than wiping out the interior of the fixture. It is quite possible that any necessary repairs can be done at that time if the service truck is stocked with a small quantity of the principal renewal parts (glass globes, insulators, sockets, film cutouts, etc.).

No effort seems too great for a bug who wants to see the inside of a luminaire or floodlight. Globe or lens holders that are opened for re-lamping seem to be the favorite point of entry and it may be observed that gasket deterioration has a good deal to do with the rate at which bugs accumulate inside the luminaire. Factory sealed globeholders are much better in this respect; but if this type is not used, it will be necessary to see that gaskets are renewed frequently enough to keep the equipment tight.

Be sure that the openings through which external wiring enters the body of the luminaire are caulked, that unused wire openings are plugged, and that a small quantity of copper or steel wool is stuffed in the pipe bracket, if one is used.

These same means are also effective against the entrance of water and dirt. The slope of the pipe bracket supporting the luminaire should be checked occasionally as sometimes a pole settles and slopes the bracket toward the luminaire. It is preferred that the bracket slope downward toward the pole at about 5 deg. from the horizontal, to conduct any moisture away from rather than into the luminaire.

Normally, wiping out the interior of the luminaire with a clean cloth when re-lamping should be sufficient on a well-sealed luminaire. However, if actual washing is required—it may be on the outside if not the inside—a lukewarm water solution of a highly soluble neutral soap should be used. If Alzak finished aluminum reflectors are involved, a special cleaner may be required for the obstinate spots that the soap solution will not remove. General Electric Type D-50R1 is such a cleaner containing a moderate quantity of mild abrasive and liquid wax. Strong acid or alkaline cleaners or coarse abrasives should not be used.

LAMP SERVICE RECORD

OUTDOOR LIGHTING SYSTEM MAINTENANCE

POLE NO.: 140 LUMINAIRE: G.E. Form 72 VR

LAMP TYPE AND RATING: Sirius, 6000 lumen 6.6 amp. group replacement.

DATE	REG. OR SPL.	HOURS SINCE LAST REGULAR REPLACEMENT	DUE FOR REPL.	REMARKS	DATE	REG. OR SPL.	HOURS SINCE LAST REGULAR REPLACEMENT	DUE FOR REPL.	REMARKS
5/25/42	Reg.	2250	12/22/42						

OBVERSE SIDE

MAINTENANCE AND REPAIR RECORD

OUTDOOR LIGHTING SYSTEM MAINTENANCE

POLE NO: 140 LUMINAIRE: G.E. Form 72 VR

DATE	REPAIRS OR REPLACEMENTS MADE	DATE	REPAIRS OR REPLACEMENTS MADE
5/25/42	tightened loose connections		

REVERSE SIDE

Fig. 4. Typical service record form

Fig. 5. Immerse the reflector globe assembly in the soap solution; rotate to wet all surfaces thoroughly inside and out. Drain out soap solution

Fig. 6. Place on board and rub all surfaces with a cloth soaked in the soap solution. A bristle brush may be used on outside

Dampness, salt fog, acid fumes and coal smoke sometimes cause decomposition of metal parts. Paint should be applied to protect exterior surfaces that need it. Such paint should be carefully selected for durability and exposure to weather and the operating temperatures of the device.

An essential part of the plan is some way of assuring that the inspection is actually made at the time of lamp replacement. For that purpose, it is suggested, first, that each pole in the outdoor lighting system be numbered, and second, that a work report form be made which the service crew chief has to fill out and turn in each time he does anything on any of the outside lighting equipment. Because there may be occasional service calls at other times, it may be desirable to set up a work record for each luminaire on which the information from the work report is posted. This will reveal any particularly troublesome piece of equipment which can thereupon be carefully investigated.

It will usually expedite general or special maintenance trips to have a map of the property showing the number and location of each pole as well as the location of transformers, control apparatus, fuses, etc., and such landmarks as will enable the workman to go directly to any desired point without necessarily following the circuit around the property. The map might well show the sizes of lamps, fuses, and film cutouts required at each location.

Figures 1, 2 and 3 contain suggestions for report form, record forms, and map.

Transformer and Control Equipment Maintenance

As a part of the general maintenance program, it is advisable to check up on the lighting system transformer equipment occasionally. It is very essential that proper voltage or current be supplied to the lamps if the expected light output and lamp life are to be obtained. In the case of a multiple system, it is possible that other loads added to the circuit or to the primary supply may substantially reduce lamp voltage. Thus it is worthwhile to check the voltage at several points with the lamps burning, every 6 mo. or so. In the case of series circuits, the lamp current is held constant by a constant-current regulating transformer; but this, too, might well be checked once a year.

An important but often ignored check point for transformers and oil switches relates to the quantity and quality of insulating oil. There is the possibility of deterioration of quality through condensed moisture and sludging which, if allowed to become extreme, can be expected to result in a burnout or serious damage to the apparatus. All such apparatus is provided with convenient oil drain and sampling plugs by which a small quantity of oil can be withdrawn for analysis; and it is a simple matter to remove the cover to see that the oil level is where it should be.

As in the case of luminaires, it becomes much simpler to know what was done and when it was done if suitable records are kept. The record kept for each transformer might well indicate its type and rating, name of manufacturer, location, and date installed. Space should be provided for entry of inspection and maintenance records so that the history of a device can be studied if desired. This may be very useful if operating difficulties appear repeatedly or if relocation of equipment or system changes become desirable.

For the interest of those who may have had no previous experience with series outdoor lighting circuits, here are a few pointers on maintaining service.

Where burned sockets and receptacles are encountered, the most common cause is the use of an improper film cutout or a piece of dielectric material which actually has no protective value. In years past, service men have been known to substitute all manner of materials — matchsticks, friction tape, cigarette papers, etc.—which obviously cannot function in the safe, protective manner of a proper disk or film cutout. Therefore, it is very essential that service crews be provided with sufficient quantities of proper film cutouts so that there will be no excuse for such substitutions.

A well constructed series circuit is satisfactorily free of circuit faults, but if it should happen that circuit outages develop to a serious extent from broken connections, a practical help in locating the faults is available. By providing for grounding the circuit at intervals of, say, ½ mi. and at either side of the constant-current transformer secondary, open-circuited portions of the line can be shorted through ground and the section of the circuit where the open circuit has occurred may thus be located. An examination of the wiring in each luminaire then follows.

The means used to ground circuits may be primary cutouts with disconnecting blade doors. One side of each cutout is connected to the circuit and the other side to ground, the door being carried in the service truck. Or, it is possible to use an ordinary street lighting luminaire hood with a series receptacle permanently connected into the circuit. This is plugged into a series socket with insulated flexible cable connected to a ground rod provided for the purpose.

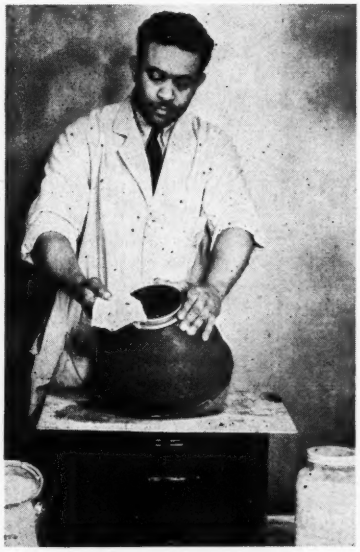


Fig. 7. Tungsten oxide from exploded lamps or other substances not already loosened can be removed by scrubbing with D-50R1 (G.E.) Novalux or comparable cleaner on a damp cloth

Considering the fact that series circuit voltages are about the same as primary distribution voltages, it is generally advisable that no work be done on equipment connected to the series circuit until the circuit has been de-energized. A most satisfactory way to assure this is to remove the door of the fuse cutout in the circuit supplying the constant-current transformer. Even with this assurance, workmen should handle these series circuits as if they might become energized at any moment. Electric utility companies have operated high-voltage series circuits successfully ever since the beginning of electric street lighting, but that dependability and safety has involved, among other things, insistence on strict observance of safety rules.

What the OPERATOR Wants to Know

Part III.* Steam temperature and combustion control as influenced by economics, fuel and load conditions with particular reference to such operating variables as: furnace and superheater cleanliness; distribution of radiant and convection surfaces; entering gas temperature; mass gas flow through the convection boiler surface; feedwater temperature; coal fineness and burner maintenance; and control facilities provided

by Alfred Iddles, Application Engineer, The Babcock & Wilcox Co., New York, N. Y.

WHEN PURCHASING steam generators, it is customary for buyers to specify the outlet steam temperature desired, and recently in most cases, there has been a further request that the temperature be maintained from full load down to some percentage thereof. Most inquiries also give the feedwater temperature, but frequently omit to state how this temperature varies with load. The designer of the unit must in his calculations assume the method of burning the fuel and the excess air that will result, so that the mass flow of furnace gases through the convection surfaces may be known.

In other words, the amount of fuel to be burned for a given amount of steam depends upon: the feedwater temperature; the outgoing steam temperature; and the efficiency of the unit. The outgoing steam temperature will depend upon: pressure; gas temperature; gas mass flow through the convection superheater, or the heat head available to the radiant superheater; and the cleanliness of all heat absorbing surfaces.

The designer's job is to choose these variables in accordance with the available apparatus and conditions, and if he does this correctly, then the operator has been provided with an apparatus with which he can obtain what he has asked for. He cannot, however, obtain this without considerable effort and careful supervision of operation.

For instance, the satisfactory operation of the burners may depend upon the proper operation of the pulverizers and will certainly affect the accumulation of dry or wet slag on the furnace walls. This accumulation in turn affects the heat absorbing capacity of either the radiant superheater or the water walls. This in turn materially affects the temperature of

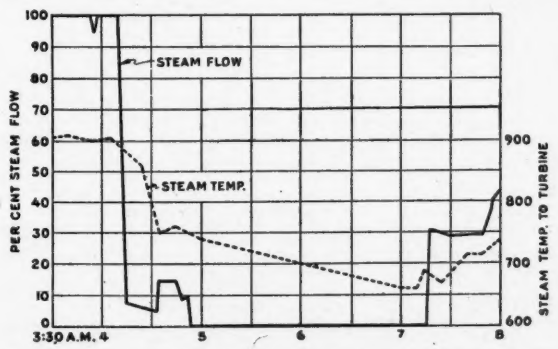


Fig. 4. A long accidental station trip-out of a single 1250 lb. boiler and a single-shaft condensing turbine (with no steam bypass) following a steady load period

This should be of interest to those concerned with the effect of rapid temperature-changes on turbines. For about 15 min. after the trip-out the steam temperature dropped but little, and had the turbine been put back into service within this time, it would not have been subjected to a temperature change exceeding 35 or 40 deg. F. The temperature dropped suddenly when it did start down, however, and in the 25 min. before steam was readmitted, the temperature went down to 750 deg. F. There was no way to increase this temperature, because the fires had been extinguished and there was no outlet for steam except to the one turbine.

An attempt was made to start the turbine with 750 deg. F. steam (4:35 to 4:45 A. M.), which is undesirable, as far as the turbine is concerned. A small steam-flow was continued for about 10 min. and the throttle was closed with the turbine kept on the turning gear until 7:15 A. M. It was then put back on the line with 660 deg. F. steam, and the steam flow was increased from 0 to 30 per cent within a minute or so. This was maintained for about 35 min., during which the temperature climbed back up to 725 deg. F. From then on, load and temperature were gradually increased to full load conditions.

*Part I, with Figs. 1 and 2, appeared on p. 60 of the September issue and Part II, with Fig. 3, on p. 70 of the October issue. This material was presented by the author extemporaneously before the Metropolitan Section of the A. S. M. E. and the informal style of the oral presentation has been retained. Parts I and II and the first page of Part III served as a general introduction to the "look at the record" part of the talk in which slides, made from operating records, were used to illustrate specific points of good and bad operation.

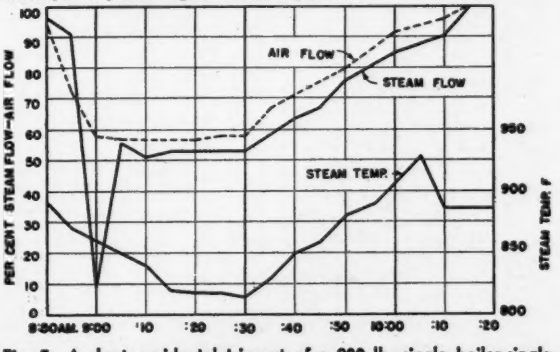


Fig. 5. A short accidental trip-out of a 900 lb. single boiler-single turbine (condensing) plant with no steam bypass

Following an accidental trip-out, the steam flow dropped from 90 to 10 per cent in about 5 min., during which time the temperature dropped from about 870 to 860 deg. F. The flow was re-established to the turbine and back up from 10 to 55 per cent in the next 5 min., during which time the temperature dropped to approximately 850 deg. F., and continued to drop (at this 50 per cent flow) for about 25 min. or until 9:30 A. M. It had then reached 815 deg. F., but from then on it gradually picked up as the load was increased from 55 to 100 per cent. Notice that the steam temperature overshot the normal operating level of 880 deg. F., between 10:00 and 10:10 A. M., going as high as 925 deg. F. before being brought back to 885 deg. F. for normal operation. This sequence of events produced no outward signs of difficulty in the turbine.

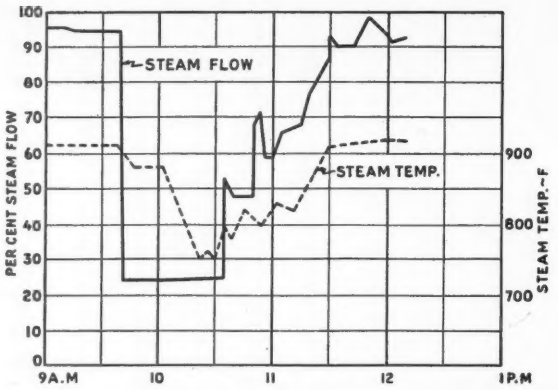


Fig. 6. Another accidental trip-out in a 1250 lb. topping plant with two boilers and one turbine, where considerable quantities of steam can be used for purposes other than the topping turbine

The steam flow was reduced from 95 to 25 per cent almost instantly, but the station has other uses for steam, so that the flow was not reduced to zero, even though the turbine throttle valve was closed. This condition continued for approximately 1 hr., during which the temperature dropped from 925 to 750 deg. F. Beginning at 10:40, the turbine was loaded quite rapidly, so that by 11:30 A. M. the unit was back to full load. In this case the topping turbine was able to stand this change in temperature without external signs of difficulty. This chart shows very clearly the lag in steam temperature change behind the steam flow. With the 25 per cent of flow it took almost 40 min. for the temperature to reach its minimum at 750 deg. F.

gases entering the convection superheater.

Not only the temperature available, but also the gas mass flow passing through the convection superheater, is entirely dependent upon combustion conditions. Therefore, the methods of control will in large measure determine the accuracy with which superheated steam temperature can be maintained.

Another important item frequently overlooked is the fact that the heat put into the steam for a 1250 lb., 950 deg. F. job may be as much as 25 per cent of the total heat input to the unit. To do this the superheater has been placed nearer or partly in the furnace. It is therefore more sensitive to furnace conditions. Add to this the fact that the specific heat of steam at 1400 lb. and 950 deg. F. is only 0.6 of a B.t.u. per pound per degree difference, and it is easy to see that it takes only a small amount of heat to produce a degree difference in temperature in this range, and the result is greater difficulty in controlling temperature.

Accurate control is of course desirable, but it is difficult to obtain. There is no denying the fact that in modern practice it is much more important to be accurate in steam temperature, since 950 deg. F. is approaching the limit on available material, both in the turbine and in the superheater. This does not minimize the necessity for seeking this goal, but emphasizes that it can be done only by proper design and eternal vigilance, and the latter is up to the operator.

The steam temperature desired by a power plant designer is usu-

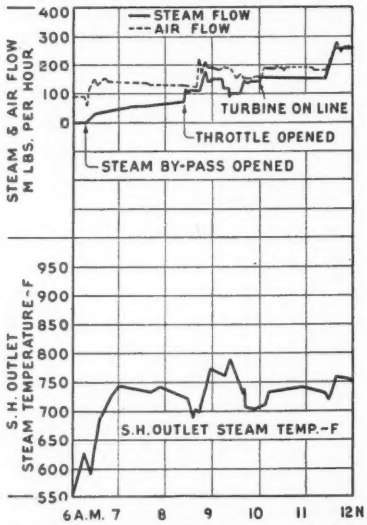


Fig. 7. Starting conditions are materially improved if a bypass is available. This chart shows a 900 lb. single boiler-single turbine (condensing) plant coming on the line

This plant is so arranged that the boiler can be brought up to partial load by the use of a bypass, through a reducing valve, to the headers in the old station. This made it possible to bring the boiler load up to 25 per cent and the steam temperature from 550 to 740 deg. F. before opening the turbine throttle. If the turbine is being started from cold, this is of little consequence, but is important in starting the turbine after a relatively short shutdown when temperature conditions in the turbine favor the steam at a temperature higher than would be possible without the bypass available. Some designers believe this is a desirable arrangement, and have even considered house turbines as a means of absorbing a certain amount of heat from the boilers before starting the main turbine.

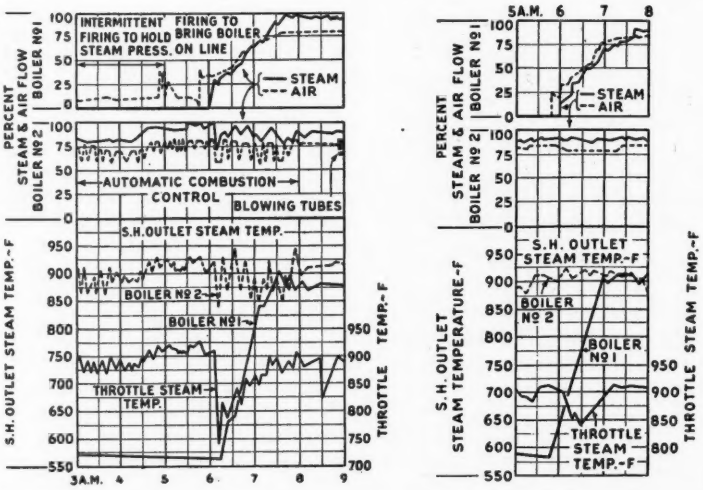


Fig. 8. Starting cycle in a 1250 lb. topping plant, with two boilers and one turbine, as the second boiler is cut in to carry the morning load. Left, original operation with automatic combustion control and manual temperature control. Right, operation as improved by experience and the use of manual control of both combustion and temperature

In this plant the load cycle requires reduction to less than half generator output each night. To maintain high steam temperature at less than half load on the generator, the operator chooses to run one boiler at night within its temperature control range and at full 925 deg. F. temperature. In the morning when the generator load is to be increased rapidly, a problem arises in connection with steam temperature to the turbine resulting from the cold boiler coming on the line. This chart shows conditions on one characteristic morning start-up while the two boilers were on automatic combustion control and manual temperature control. This chart is from an early stage in the operation of this new station. Note that the turbine had been operating during the early morning hours at approximately 900 deg. F. at the throttle. Just before the second boiler was brought on the line, the temperature at the turbine was 925 deg. F. at about 5:45 A. M. No. 2 boiler, which had been on the line at night, was operating at 93 per cent of full load. No. 1 boiler at zero flow was put on the line at 6 A. M. and the steam temperature was 570 deg. F. Notice the bad swings in excess air for boiler No. 2 under automatic control.

Number 1 boiler increased from zero to 28 per cent flow in about 10 min. No. 2 dropped from about 93 per cent to 70 per cent flow and the temperature on this unit decreased to 840 from 925 deg. F. The mixture from the two boilers produced steam at 750 deg. F. at the turbine throttle. This sudden drop from 910 to 740 deg. F. in perhaps 5 min. is a condition which the turbine designers desire to eliminate. It took about 1 hr. 20 min. for the throttle steam to again reach its design temperature of approximately 900 deg. F.

Curves at the right show the same station after improvements in operating technique had been worked out. More accurate control of combustion conditions and of load adjustment on the two boilers is noticeable, and produced a considerable improvement as far as temperature shocks to the turbine are concerned. During this load change cycle both combustion and temperature control were on manual operation. The boiler in operation, during the night, was kept at substantially constant load and not permitted to drop either in flow or in temperature. The excess air swings have been eliminated, as compared with earlier operation. The oncoming boiler increased in its output temperature from 575 to 900 deg. F. in about 1 hr. 15 min. and the drop in throttle temperature started at 900 instead of 925 deg. F. and dropped only to 840 deg. instead of 750 deg. F., characteristic of the previous method of bringing on the cold boiler. The temperature to the turbine recovered in 40 min. instead of 1 hr. 20 min., all of this indicating an improvement in operating technique.

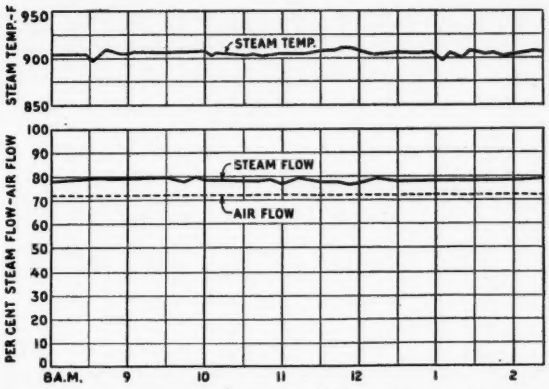


Fig. 9. Steam temperature variation held to plus or minus about 6 deg. under steady steam flow to a condensing turbine with constant load

This plant operates at 900 lb. 925 deg. F., one boiler and one turbine, and the chart shows conditions under automatic combustion and temperature control. In this instance the temperature control is by manipulation of dampers at the outlet of the superheater and the gas bypass section.

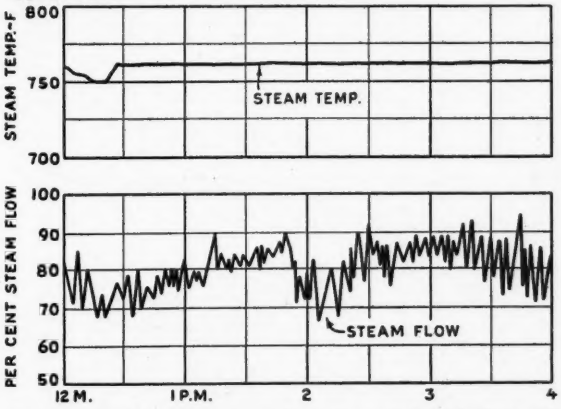


Fig. 10. Good temperature regulation in an industrial plant with violent load swings as contrasted to the constant load in Fig. 8

This chart was taken from a 750 lb. 750 deg. F. unit supplying a single turbine on a steel mill load. The load swings violently, as is characteristic of such industrial loads, and special provision was made on this unit for steam temperature control by means of an interstage cooler in the superheater circuit.

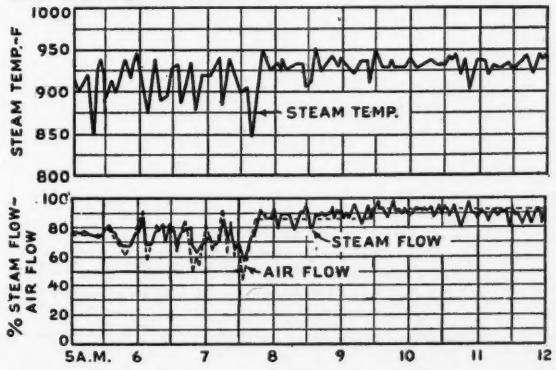


Fig. 11. Wide load swings in a 1250 lb. installation, three boilers and one topping turbine, showing operation with manual and automatic (after 8:00 A. M.) control

The frequency of load swings is such that automatic control as applied in this instance is unable to keep up with the situation. The resulting swing in steam temperature shown on the left between 5 and 8 A. M., swinging as it does between 850 and 950 deg. F., must throw a considerable burden upon the metals in the superheater, upon the turbine, and upon the valves and piping. These temperature changes of 100 deg. result from load swings between 60 and 90 per cent. The period from 8 A. M. to 12 M., shows similar conditions when the automatic combustion control was replaced by manual control. A part of the improvement in temperature is due to a reduction in size of the load change, apparently because, under manual control, hunting between three boilers was largely eliminated. This illustrates the problem facing a plant designer who must determine what type of control is feasible for the expected conditions, and must also consider what fluctuations in flow and temperature will be acceptable to the turbine.

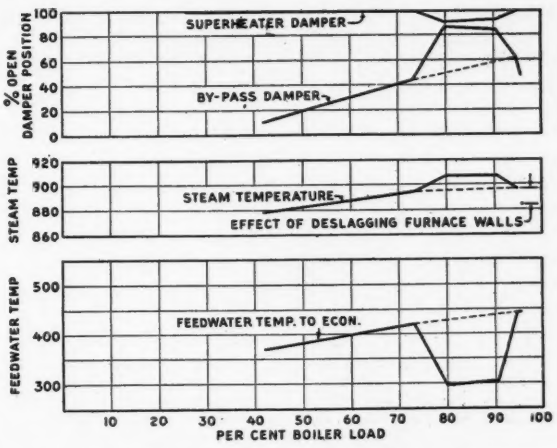


Fig. 12. Effect of furnace wall deslagging and feedwater temperature on a 900 lb. unit under steady load conditions

This unit normally operates without either hand or mechanical cleaning in the tangent-tube walled furnace head of the convection superheater. In order to show the effect of removing the very small amount of dry sponge ash that is usually present in that location, tests were made and the results shown by the curves. At about 95 per cent full load the unit had been operated over several days during a series of tests, and then special effort was made to clean these furnace walls. The result is shown at the right hand side of the curve indicating a drop in temperature from about 896 to 883 deg. F., with all other conditions constant. This is a modest example of the effect of cleaning furnace walls ahead of superheaters. There are many jobs in which a change in steam temperature from 50 to 75 deg. can be made by manipulating the slag covering on the furnace walls, either by the volition of the operator or by natural conditions resulting from changes in load. Under circumstances where such wide variations in temperature result from variations in slag conditions, the method chosen for controlling steam temperature must obviously, be of large capacity, or suitable control will not be obtained.

If a gas bypass damper is used, it must be not only able to handle changes in temperature resulting from changes in load but also to care for variation in slag conditions and, if at all likely, also to care for changes in feed temperature and in excess air. A bypass damper, to provide full temperature at low load with a clean boiler and the same temperature for full load with a dirty boiler, would have to be larger than is usually physically possible. Other means of controlling this wide range of heat absorbed in the superheater can be provided, but the resulting design must be considered in the light of its cost, and any design must be made with a full realization of conditions of excess air and slag which will actually exist.

The curves also show conditions on the same unit when different feedwater temperatures are provided. During this series of tests, one of the stage heaters was out of commission a portion of the time. Note that the feed temperature to the economizer dropped from about 420 to 300 deg. F. at a load of about 75 per cent. The steam temperature increased 20 deg. in spite of the fact that the dampers were changed to largely offset the effect. The bypass damper was opened from 45 to 85 per cent and the superheater damper was throttled about 12 per cent. Actually the design temperature for this unit is 915 deg. F., showing that the temperature resulting from lowering the feedwater was acceptable with no greater damper manipulation.

Where a wide range of load with constant superheat is desired, it frequently is desirable to alter the excess air and resulting mass flow of gas through the superheater to obtain the desired heat absorption. This increase in excess air increases the dry gas loss at the boiler outlet but in the lower load range this is not a large item and in some instances the value of higher steam temperature at the low load is greater than the cost. This is an effective means frequently used even though not originally provided for in the design.

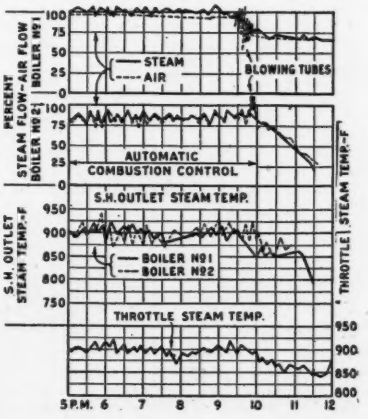


Fig. 13. (Right) Poor temperature regulations on a 1250 lb. unit while the automatic combustion control was having difficulty in proportioning the fuel input to the steam load

On Boiler No. 1 the air-flow pen was constant because of manual control, whereas on Boiler No. 2 the steam flow and air flow rapidly fluctuate over a considerable range. While in general the air flow moved in the same direction as the steam flow, there was a sufficient lack of synchronization, so that (as shown by the S.H. outlet curve) the temperature from Boiler No. 2 was swinging over a much wider range than from Boiler No. 1, with no change in excess air but with some change in steam flow. The fuel input is necessarily tied in with secondary air, if desirable combustion conditions are to be maintained, but, unless these two are synchronized, the resulting swings in steam temperature may be greater than desired. Ordinarily such variations amounting to nearly 70 deg. are not acceptable.

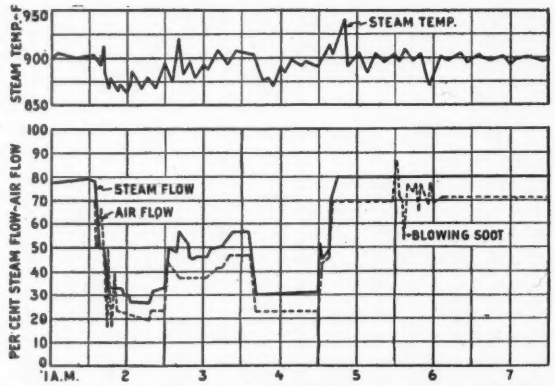


Fig. 14. Temperature regulation difficulties in this single boiler-single turbine plant under changing load due to poor secondary air conditions under manual control

Even with constant steam flow from 5 to 8 A. M., the attempt of the automatic control to maintain constant steam pressure resulted in variations of steam temperature from 874 to 935 deg. F. The largest swing was just before 5 A. M. and resulted from overshooting the temperature mark with the rapid increase in load from 30 to 80 per cent. This is a condition very difficult to control. The chart shows, prior to 5 A. M., ragged temperature regulation over rather large changes in load, although it represents what is considered fairly good practice in a great many stations. It is not, however, as good as is possible nor equal to what many expect.

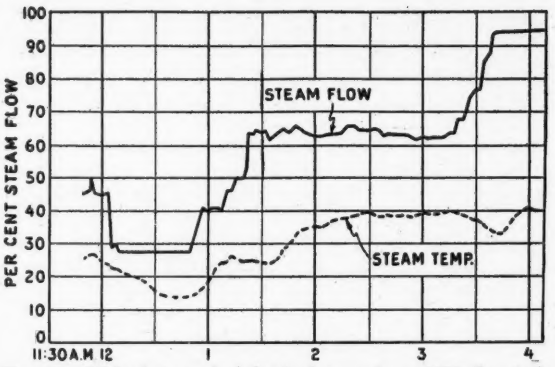


Fig. 15. Wide but gradual load changes in a 1250 lb. single boiler-single turbine unit under manual control showing the lag in temperature after load changes

Note the lag in temperature after a sudden load decrease at 12:05 P. M. and the corresponding lag when the steam flow was increased from 28 to 65 per cent between 12:50 and 1:20 P. M. It took from 1:20 to 2:30 P. M., or 1 hr. 10 min., to equalize combustion conditions and to bring out the stored heat, in order to establish equilibrium, so that the steam temperature would return to normal at 65 per cent load, at which it normally is at design temperature. The temperature remained at 890 to 900 deg. F. from 2:30 to 3:15 P. M. (at approximately 65 per cent load). Then dropped some 35 deg. in 30 min. after a sudden increase of steam flow from 65 to 95 per cent. In this plant manual control could have been faster, but the customer considers this good and prefers to run slightly under, rather than overshoot, the mark after sudden changes in load.

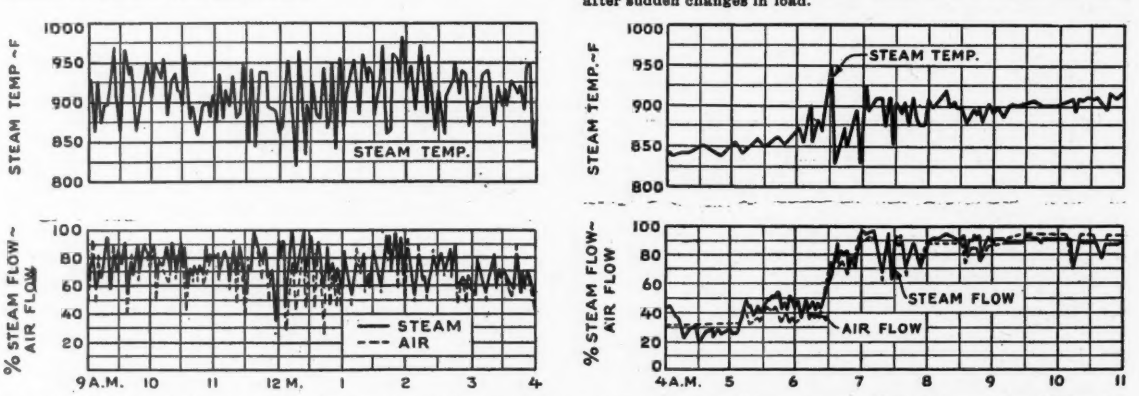


Fig. 16. In this 1250 lb. topping installation, three boilers per turbine, temperature regulation was materially improved by shifting frequency regulation from the high-pressure (left) to the low-pressure (right) generating units.

In this plant automatic combustion control was in use and the topping turbine was connected with automatic frequency regulation for a system in which the load swings were large. This imposed an especially severe duty on the boilers, which, as the chart on the left shows, resulted in wide swings in temperature from 825 to 975 deg. F. with steam flow changes in the order of from half to full load. These conditions were very severe, both on the superheater and on the turbine, and have since been changed by improvement in control and also by shifting from frequency regulation on the high-pressure turbine to such regulation on the low-pressure turbines, which have considerably more total capacity.

The chart on the left shows the same plant, still with automatic combustion control but with frequency regulation on the low-pressure turbine. Note that the load from 8 to 11 A. M. is much more constant on steam flow and the temperature is largely between 875 and 910 deg. F. The period between 6 and 7 A. M. shows overshooting the temperature to 950 deg. F. with an increase in steam flow from 40 to 90 per cent. The rapid decrease in temperature from the high of 950 to the low of 830 deg. F. shows the effect of overshooting the control to reduce the temperature, and only after about an hour, at 7:30, were conditions ironed out to maintain a fairly good superheat control condition.

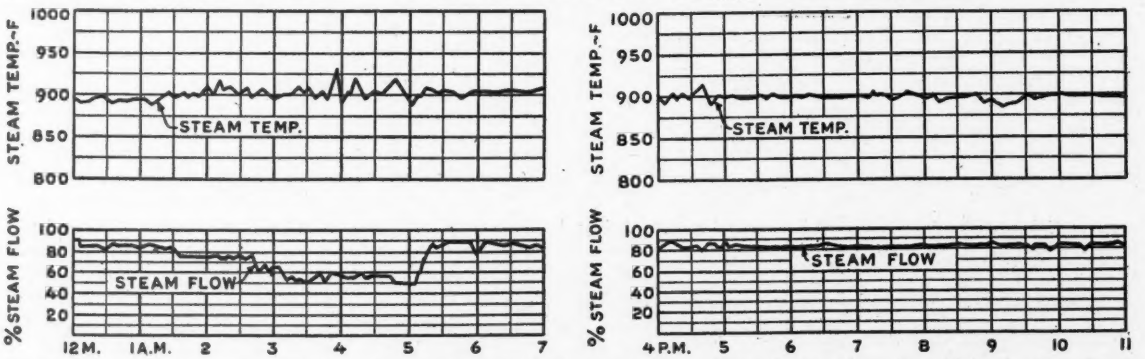


Fig. 17. Good temperature regulation in a single boiler-single turbine plant under variable (left) and constant (right) load conditions

On the chart at the left the load was varying between 50 and 90 per cent in periods of 15 min. Temperature was between 886 and 930 deg. F., or plus 30 and minus 10, for the worst or very sudden load change at about 5:10 A. M. With normal variation in load or slow changes, as indicated between 1 and 3:30 A. M., the temperature was maintained well within the plus or minus 10 deg. This unit operates with an interstage cooler between two sections of the superheater. The chart was taken while the unit was on automatic control. The chart at the right shows a much more steady load condition, varying between about 78 and 88 per cent of load. Temperature changes at the worst varied plus 12 and minus 15 deg. and, in general, plus or minus 5 deg. from the 900 deg. F. for which control was set.

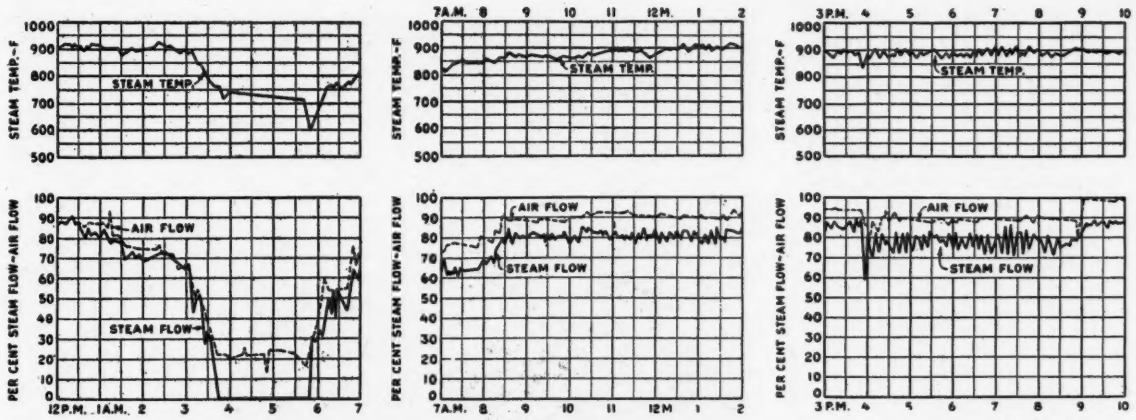


Fig. 18. Three charts showing operation of large 1250 lb. slag tap units (two boilers in parallel on one topping turbine) under load change during a normal cycle (left), with the load coming on (center) and under rapidly swinging loads (right)

The curve on the left shows conditions under a gradual reduction in load from 90 per cent to 0 in about 3.5 hr. Notice that steam temperature remained at 900 deg. F. for a reduction from 90 to 65 per cent in the first 3 hr. The load dropped more rapidly, from 65 per cent to 0 in 45 min., and the temperature followed very closely down to 725 deg. F. It then remained above 700 deg. F. for nearly 2 hr., because the well-insulated pipe, where the thermometer was located, showed no decrease in temperature because there was no steam flow. At 5:45 A. M., when the steam was again drawn from the unit, the temperature dropped very quickly from 715 to 600 deg. F. and then picked up quickly with the increase in load, until at 65 per cent load the temperature had recovered to 800 deg. F. On the reducing load cycle, the temperature was up to substantially 900 deg. F. at the same per cent of full load, this clearly showing the lag in temperature behind changes in output.

The middle curves are from the same unit on the same day but with a very steady load ranging only 5 per cent above and below a median line of 80 per cent load. The temperature gradually increased during the first 4 hr. of this period because equilibrium had not yet been reached on the increasing load cycle. It did reach this equilibrium for the last 3 hr. on this curve and with substantially constant load shows a maximum temperature variation of 30 deg. below and 20 deg. above 900 deg. F.

Curves on the right show the same unit later in the day with a more violently swinging load but over relatively small per cent change of about 15 per cent. The temperature follows up and down swings of load with short repetitive swings in temperature of 10 deg. above and 25 deg. or so below 900 deg. F. This unit has a gas bypass damper and was operating under automatic control for both combustion and temperature.

ally a matter of economics, but also involves an evaluation of the operating effect of the chosen temperature upon the steam-generating unit, and upon the turbine and other related equipment, such as valves, piping, etc.

Principal variables affecting superheat temperature are: (1) Cleanliness of the furnace; (2) available heat head to the radiant superheater; (3) temperature of gases entering the convection superheater; (4) cleanliness of the superheater; (5) gas mass flow through the convection surface; (6) feedwater temperature; (7) character of ash and slag as it affects heat head in the furnace and absorption characteristics of radiant and convection superheater and boiler surface; (8) design arrangement provided for controlling temperature; and (9) load on the unit.

To follow back through the ramifications that affect these items would add up to an imposing list, most of which are in the control of the operator but some of which are controlled by load requirements, the factors which make purchasing agents buy fuel as they do, and the wisdom of the plant designer who chose the instruments and the combustion control equipment.

Changes in fineness of coal brought about by wear of pulverizers, performance of the soot blowers or the hand lancing program, the maintenance on the burners, the maintenance of the feedwater heating equipment, and the quality of the feedwater treatment, are examples of the items directly under the control of the operator which largely affect the results.

Figures 4 to 19 on the following pages illustrate both good and bad operation and show how performance is affected by the variables mentioned above. These charts made from operating records cover steam temperature conditions for many types of installation. Some are good and some are bad. Some of the bad ones have since been made better. In some cases the designer has made the improvement and in many cases the operator has been able to learn the tricks of the particular equipment and by careful attention materially improve the results.

My conclusions on temperature control, made from many observations on many units operating under various conditions, are:

(Continued on page 120)

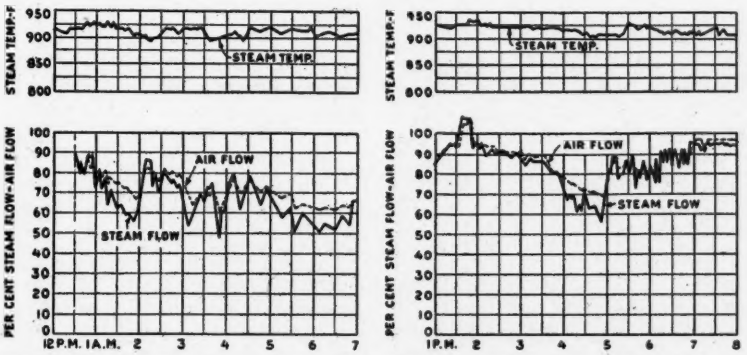


Fig. 19. Large slow load swings (left) and slow load drop followed by a rapid pick-up on a 1250 lb. unit with dry-bottom furnace operating in parallel with another to supply a topping turbine

A wide variation in steam flow with rapid increases in load, from 55 to 85 per cent in as little as 15 min., are shown by the curve on the left. The resulting temperature curve is excellent, with changes of plus 15 and minus 23 deg. below the 915 deg. F. for which operation was set. Notice the increase in temperature from 892 to 918 deg. F. that occurred during the decrease in steam flow, between 2 and 3 A. M. and immediately following a rapid increase in steam flow that occurred at 2 A. M. Again at 3:40 A. M. the load decreased very rapidly, but the temperature increased from 895 to 900 deg. F. over the same period.

Curves on the right show the same unit again with a higher peak load, up to 110 per cent, with a maximum steam temperature of 935 deg. F. Temperature was maintained above 905 deg. F., even with the drop to 58 per cent of full load. Throughout the wide change in rating between 1:30 and 4:45 P. M. the temperature was 15 deg. above and 15 deg. below the median line of 920 deg. F. Note the rather violent changes in steam flow between 5 and 7 P. M. with the temperature curve showing less violent fluctuations resulting in 10 deg. above and 10 deg. below the 920 deg. F. median line.

Fig. 1. Standby power equipment at the DeLaval Steam Turbine Co., showing battery, motor-generator set, and controls

Emergency Power Supply for Continuous Machining

By H. M. MARTIN
Motor Division, General Electric Co.

THE PROCESS of gear cutting now turns out pinions and gears which are so mathematically exact that they are capable, with only small losses, of transmitting torques and horsepowers considered impossible a few years ago.

Much of the success which has attended the use of these modern gears is attributable not alone to the precision and exactness of method of manufacture, but also to the continuity of operation which accompanies the final cut. It has long been known that if the process of making the final cut on a gear is interrupted, there is a change in the profile of the face of the tooth being worked upon. This constitutes an imperfection and, if a perfect product is desired, the gear may have to be recut or scrapped.

Imperfection of this kind usually occurs when there is a small amount of backlash between the driving motor and the cutter and also in the gear train that drives the gear itself. No matter with what care this backlash is taken up, the imperfection results.

To prevent possible damage to very large marine gears and to prevent loss in time and money due to spoilage, Gilbert Smith, chief electrician of the DeLaval Turbine Co., asked the cooperation of the General Electric Co. and the Edison Storage Battery Co. in developing and furnishing a standby power system which would be so automatic in operation and so trustworthy that in the event of failure of the normal power supply it could be relied upon to take over instantly the power supply to the gear-cutting motors. This equipment was to be so designed that on the return of the normal power supply the changeover would be made with equal reliability and smoothness. Further, it was stipulated that the subsequent recharging of the storage battery to replace the energy taken out during a power interruption should be completely automatic and performed in the shortest possible time consistent with good practice.

To meet these needs the system shown in Fig. 1 and outlined in Fig. 2 was developed. The power supply is a 3-wire, d.c., system with 230 v. across the outside legs of the circuit and 115 v., each side to neutral. It is fed from a privately owned generating plant which also supplies power to various other departments in the factory.

It should be explained here that storage batteries have been used for quite some time as an instantly available source of emergency power for applications such as these. The system described here, however, is novel in the method of applying storage batteries.

Referring to the wiring diagram (Fig. 2), the power from the 3-wire

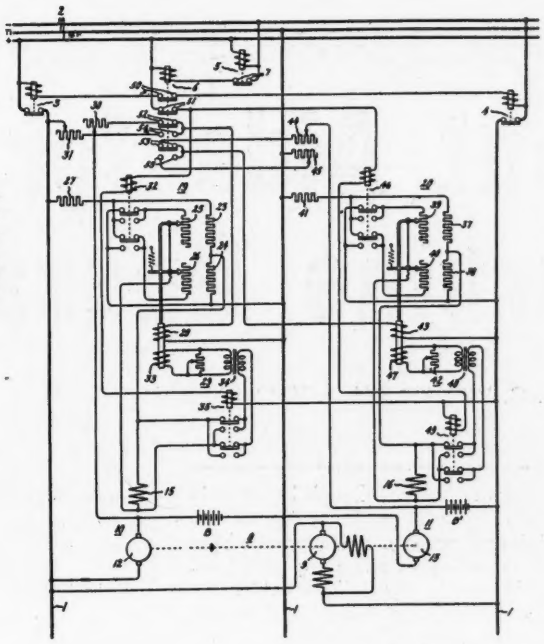


Fig. 2. Wiring diagram of automatic standby power equipment for gear hobbing operation at the DeLaval Steam Turbine Co.

system comes through contactors 3 and 4, and the gear cutter motors (not shown in the diagram) are connected to the 3 conductors at the bottom of the diagram marked 1. Some of the gear cutter motors are on one side, some on the other, and some across the outside legs of the system. It was necessary, therefore, to duplicate the control (Fig. 3) so that the two sides of the system would be balanced, particularly during a time of power interruption and also because of the difference in the flow of power to and from the storage batteries on each side of the neutral. The two batteries marked B and B^1 are always in series with the armatures of the two generators 12 and 13, while the motor driving the two generators, or being driven by them is shown at 9 in Fig. 2.

Referring to the top of the diagram, attention is called to the relay, 5, whose operating coil is across the outside legs of the system, normally 230 v. This relay is so adjusted that it drops out at approximately 222 v. and comes in again at a few volts higher. Its function is to open or close relay 6 which in turn controls several circuits.

From this point on, without referring to the numbers on the wiring diagram, this relay when its operating coil is opened, drops out the two normal supply contactors, transfers the point of voltage regulation from the two batteries to the two sides of the 3-wire system feeding the gear cutter motors, and then changes the value of the regulated voltage from the normal 150 to the "emergency" 115.

As a result of these almost instantaneous connection changes, each battery now passes from charge to discharge at a voltage considerably higher, on each side of the system than is required. The two generators now change from 'boosters' to 'buckers' thereby maintaining 115 v. on each side. As the battery continues to discharge, its voltage slowly decreases, and eventually reaches a value at which time no 'buck' is required. With this system, it is even possible to maintain 115 v. (on each side) when the battery voltage falls below that figure and when this happens each 'bucker' reverses its function and becomes a 'booster' again.

When normal power supply returns, a reversal of this sequence of operation ensues, starting at the relay 5 which closes its contacts. However, when the battery begins to charge, the current is no longer the small amount which, before the power interruption, was sufficient to maintain it ready for an emergency, but is at a higher rate based on the number of ampere-hours just taken out. In this way, the battery returns to a fully charged condition in a relatively short time, the current decreasing as the charge progresses.

This system has proved to be eminently successful. Since its installation there have been several occasions, rather widely spaced in point of time, when the battery has automatically taken over the load. Only because an operator happened to be looking at the apparatus was the changeover noticed. Already, it is reported that more than half the total installation price has been saved by this equipment in that it has taken over the load of the gear cutting motors at a time when the most careful finishing cuts were being taken.

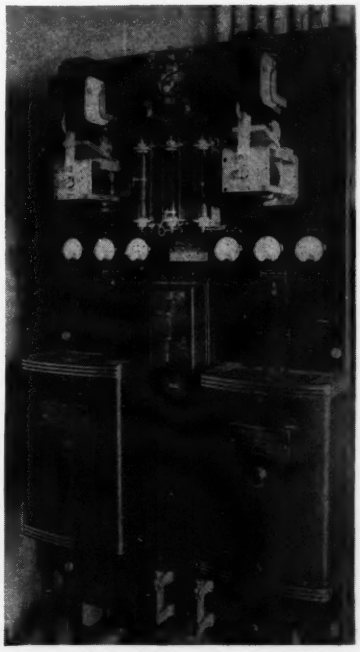


Fig. 3. Close-up of control panel for standby power system at the DeLaval Steam Turbine Co. Shown are the Meyers, under-voltage relay, disconnect contactors, and Diactor voltage regulators

SHATTERED BELIEF

Another popular belief about lightning has been shattered by research engineers. Contrary to general opinion, lightning strokes are more severe at low altitudes than in high mountainous regions, according to an A.I.E.E. report by L. M. Robertson of the Public Service Company of Colorado, W. W. Lewis of the General Electric Company's Central Station Engineering Department, and C. M. Foust of that company's General Engineering Laboratory. The report concludes a five-year study of lightning and corona currents on the Colorado Public Service Company's Shoshone-Denver 100-kv. transmission line, which runs through the heart of the Rocky Mountains.

Instrument Aids for Turbine Operation

By H. C. WERNER and G. V. KRENIKOFF*

Built with precision accuracy, the modern steam turbine, though immense in size and weight, and a giant in power, must maintain its accuracy of construction throughout its life of operation. To this end, supervisory instruments have been developed which are infinitely more sensitive to operating conditions than the human senses can ever be. In this article, the authors outline the need for several of the newer types of supervisory instruments and explain briefly their principles of application and operation. Instruments dealt with are the spindle eccentricity meter, cylinder expansion meter, shaft vibration meter and the spindle position meter. Details of design and construction are described

THE MODERN steam turbine is a precision-built machine and requires a certain amount of care and attention which is fully described in the operating instructions. In addition to following these rules, the well managed power plant maintains a set of performance records, as for example, those furnished by temperature, pressure, flow, and other recorders. The purpose of these records is two-fold: to furnish data for the systematic management of the plant and to maintain a constant check on the operation of the various units.

It is needless to emphasize here that the optimum performance of a turbo-generator unit must be accompanied by a sound mechanical condition of its parts and elements, if economical, safe, and reliable operation is to be accomplished. This rule applies to all power equipment, and the burden of keeping a check on such things is placed on the operating force.

This problem in the case of the turbine is simplified, if not solved, by the use of a set of instruments which are described in this article. To begin, let us consider the aspects of our problem. We are to start and operate a turbo-generator unit. The machine may have been shut down for only a few minutes or possibly several weeks, and the precautions necessary in starting will be influenced by the history of the shutdown. It is common experience that if a turbine spindle is allowed to remain stationary for any length of time after a shutdown, it will cool off more rapidly at the bottom than at the top, and this uneven cooling results in a warped or bent spindle. If an attempt is made to bring the machine up to speed with the spindle in this condition, it will run rough; and if allowed to come up to full speed, the resulting vibrations may be so large as to cause serious damage to the spindle, bearings, and other parts.

*Both authors are associated with the Westinghouse Electric & Manufacturing Co., Mr. Werner in the Research Laboratory at East Pittsburgh, Pa., and Mr. Krenikoff in the Engineering Department at South Philadelphia, Pa.

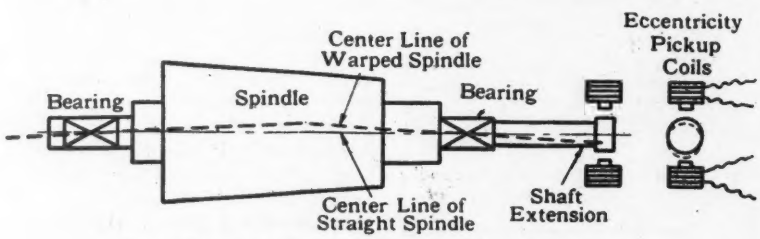


Fig. 1. Diagram showing application of spindle eccentricity meter

Detection of Warped Spindle

Thus the first concern of the operator before admitting steam to the turbine is to check the straightness of the spindle. This can be done by placing a dial indicator against the spindle while it is slowly rotated by the turning gear. All modern larger size turbo-generator units are equipped with this motor-driven device, the primary function of which is to keep the spindle turning slowly in order to insure uniform temperature and relative straightness during shutdown periods.

The point of application for the dial indicator should be some distance axially from the bearings because the spindle bends with the bearings as nodal points, as shown on Fig. 1. If the spindle is not straight, the indicator will give one high and one low reading every revolution, and in this manner measure the eccentricity or outage of the spindle at that particular point. If the eccentricity is beyond a satisfactory limit, it is necessary to start the machine with steam and roll at slow speed. As soon as steam is admitted to the turbine, the cooling process is reversed and the spindle gradually becomes uni-

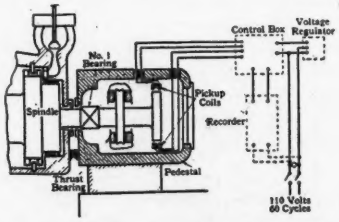


Fig. 2. Wiring diagram of eccentricity meter

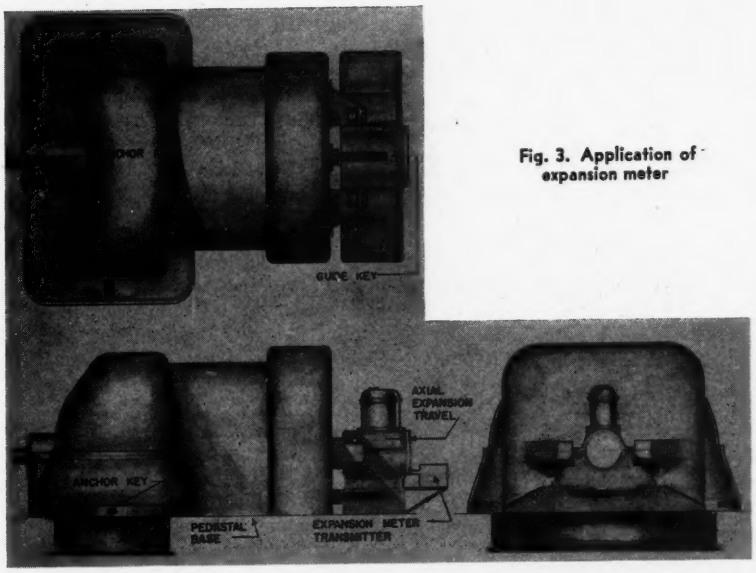


Fig. 3. Application of expansion meter

formly heated, straightening out in a relatively short time. As the indicated eccentricity becomes less, the speed of the turbine can be increased.

Perhaps nothing could be simpler than the use of a dial indicator as described. But this requires attention on the part of the operator who already has many other tasks on hand when starting. Furthermore, if full use is to be made of such information, it should be recorded at regular intervals, and this would require even more of the operator's time. Here, then, good use can be made of a type of "supervisory" instrument called the Spindle Eccentricity Meter. This meter will record and indicate on a conveniently located instrument board, the outage of the turbine spindle at the point where the so-called "pickup" coils are located. These are usually placed near the free end of the spindle extension, where the effect of bending is greatest.

The eccentricity meter employs the electromagnetic principle, extensively used by Westinghouse, for measuring small distances accurately. Two iron cored pickup coils are located diametrically opposite one another with respect to the turbine shaft (see Fig. 2), and each is separated from the shaft by an air gap. The iron core, together with the air gap and shaft, completes the magnetic path, and the inductance of the coil is a function of the magnitude of the air gap. The coils are assembled so that the air gaps are equal when the spindle is straight. Under this condition the impedances of the pickup coils are also equal and the bridge circuit of which both coils are a part, is balanced.

When the spindle is bent, however, one air gap becomes shorter while the other becomes longer, and the impedances of the corresponding coils increase and decrease respectively. The bridge circuit is now periodically unbalanced with rotation of the spindle and the resulting center leg current operates the indicating or recording meter showing the outage or eccentricity of the shaft in thousandths of an inch. The eccentricity meter, therefore, not only replaces the conventional dial indicator, but, in addition, is much more convenient and gives a permanent record.

Cylinder Expansion

The second aspect of our problem during starting and operation of the turbo-generator is thermal expansion of the casing or cylinder. As soon as steam is admitted to the machine, heat is absorbed by different parts and expansion results. If the expansion proceeds in an orderly manner, i.e., in such a way that the relative position of turbine parts remains unchanged, then we have no reason to be concerned.

To allow freedom for such an expansion in large turbines, one end of the machine is anchored to the foundation, while the other end is allowed to slide in an axial direction (see Fig. 3). To preserve the alinement of the turbine bearings the sliding pedestal is guided along a well lubricated key located in the pedestal base. A continuous motion of the pedestal as it slides along the base is a good indication that the expansion is proceeding in a normal fashion.

Although such free expansion is necessary, it, however, is not sufficient to insure trouble-free starting. As various parts of the turbine start to expand, they may do so at different rates. For example, the spindle will expand much faster than the casing. This differential expansion may in extreme cases cause actual interference between the moving and stationary parts. At low speeds such rubs can be detected easily with a listening rod. These rubs may cause local heating and result in spindle distortion with subsequent vibration.

Uneven expansion of the casing may cause misalinement of the bearing supports with the same results. Thus the rate, the extent, and the continuity of the turbine expansion all become important information. This information can be supplied by another type of supervisory instrument called the Cylinder Expansion Meter. The expansion meter makes a continuous record of the relative displacement of the sliding pedestal with respect to its base and thus gives the actual overall expansion of the casing as a function of time.

This instrument is very simple in construction, employing the well known syncrotie position indicator principle. It consists of two small poly-phase induction motors, the stators of which are wound for single-phase and the rotors 3-phase. With the rotors interconnected electrically and the stators connected to the same source of single-phase power, the receiver rotor will follow the rotation of the transmitter rotor. For the expansion meter application the transmitter is mounted on the pedestal base, see Fig. 3. By means of a rack and arrangement any relative motion between the pedestal and pedestal base results in a corresponding rotation of the transmitter rotor. This rotation is duplicated by the receiver motor which is located in the recorder and is geared to the recording pan, Fig. 4.

It is preferable that the meter be of a recording type since the rate of the expansion is just as important as the magnitude. A glance at the recorder chart will instantly give this information to the operator. Any sharp discontinuity in the line drawn on the chart will indicate that the pedestal

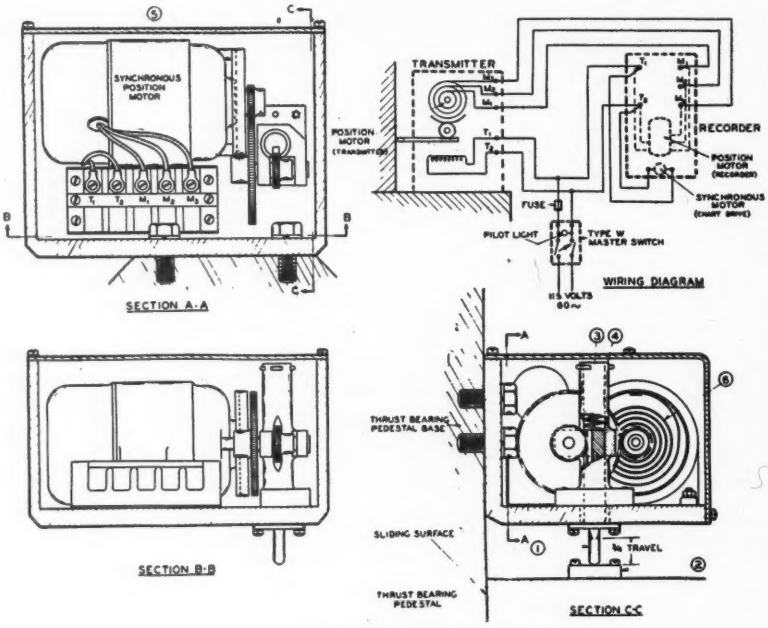


Fig. 4. Cylinder expansion meter, sections and wiring diagram

is binding or that the expansion is restrained, and this condition indicates a probable distortion to the casing. A common cause of such a record is lack of lubrication at the sliding mechanism.

Checking Turbine Vibration

In the previous discussion, emphasis was placed on the undesirability of spindle vibration. It is common knowledge that an abnormal vibration could, in time, cause serious damage to bearings and even produce fatigue failures. It follows, also, that if such a condition developed, there would, no doubt, be a corresponding gradual drift in the vibration values at different points on the machine. By watching the vibration over a period of time, the operator not only has a constant knowledge of the vibration condition, but is also warned by any abnormal changes which may be taking place. If a change occurs rapidly, the operator can sometimes detect the change without the aid of an instrument. On the other hand, if it is very gradual, the effect may not even be noticed by the most experienced operator. Herein lies the desirability of a recording instrument.

Many operators realize the importance of periodically checking the vibration of the machine. This is usually done by placing a portable vibrometer on the pedestals at regular time intervals and noting the readings. Such a procedure naturally takes a considerable amount of the operator's time and, what is more important, supplies only intermittent data.

The supervisory Shaft Vibration Meter is a decided improvement over this method. First of all, it picks up the vibration where it originates at the spindle. In the past, when the majority of units in operation were 1800 r.p.m. machines, the method of measuring vibration from the bearing cap or pedestal was considered adequate and quite satisfactory. Since these machines have heavy spindles, vibration is readily transmitted from the spindle to the pedestals. With the modern 3600-r.p.m. machine the situation is different. The spindles of these machines are much smaller, particularly those of the high-pressure turbines. At the same time the cylinders and pedestals are relatively heavier to withstand the higher steam pressures. For this reason the effect of spindle vibration on the pedestals is usually negligible. This experience has proved the inadequacy of pedestal or bearing cap vibration measurements and as a result, shaft vibrometers were developed for this type of machine. The measurements of vibration are made at several convenient points along the spindle, usually at each main journal.

The operation of the shaft vibration meter is as follows:

The pickup frame "1" bolted to the turbine pedestal (see Fig. 5) supports the shoe "2" on a shaft rider through springs "3" and "4". These springs also supply the necessary force to hold the shoe against the rotating shaft under all conditions of vibration. The pickup coil "5" is connected to and vibrates with the shoe through the connecting rod "6". The coil is located in a magnetic field supplied by a permanent magnet "7" and by virtue of its motion generates a voltage proportional to the product of the amplitude and frequency of vibration. The magnet assembly is

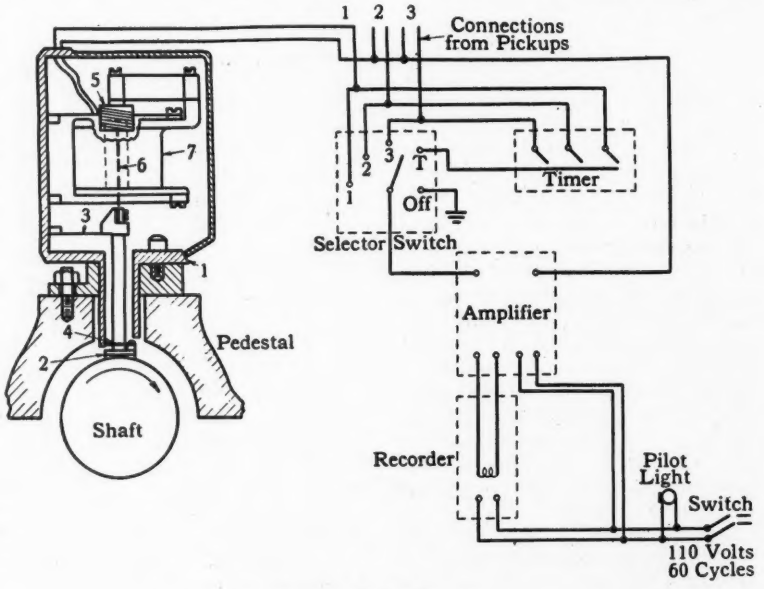


Fig. 5. Shaft vibration meter

seismically supported in the frame by four flat springs and is practically motionless in the direction in which vibration is measured. The shoe rides on the shaft just outside of the bearing and receives sufficient lubrication from the bearing discharge.

The general voltage is fed into an electrical integrator and amplifier. The integrator serves to make amplitude readings independent of the frequency or r.p.m. of the machine and, therefore, proportional only to actual amplitude at any speed between 600 to 4000 r.p.m. The integrated and amplified current is then fed to a recorder which is calibrated in thousandths of an inch.

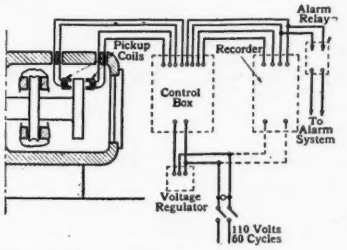


Fig. 6. Wiring diagram of spindle position meter

If several pickups are used on the same unit, the record of each station is made on a common chart in successive and periodic intervals, the length and order of which is determined by the setting of a program timer.

If an occasion arises where the operator is interested in one particular station, he may use a selector switch which provides means for cutting out the timer and connecting the pickup in question to the metering circuit.

Spindle Position Must Be Accurate

Another instrument on our supervisory list is the Spindle Position Meter. To allow for manufacturing tolerance and differential expansion in the turbine, axial clearances between rotating and stationary members are provided. Any axial spindle motion relative to adjacent stationary parts in excess of these clearances would result in a rub, and it is the function of the thrust bearing to hold the spindle within these limits. Besides providing means for the location of the spindle, the thrust bearing must also take any unbalanced axial loading. As the electrical load on the machine changes, there will be a corresponding change in the thrust load, causing a small displacement of the spindle. These spindle displacements are of interest to the turbine operator, because through them he can detect an abnormal thrust loading, as is sometimes caused by the formation of a deposit of foreign matter on the blading of the spindle. Through them he may also detect any wear that may appear in the thrust bearing itself.

Measurement of spindle position is, therefore, on the list of desirable data that the operator should keep. An "end" or spindle micrometer is usually supplied with the machine, and there is no difficulty in using it for this purpose. As with the other supervisory instruments, however, the spindle position meter will record the desired data in more convenient form and supply the operator with the history of the performance.

Operation of the spindle position meter is based on the same electro-magnetic principle as that used for the eccentricity meter. The pickup coils, however, are now arranged so as to measure axial motion of the spindle, Fig. 6. Since we are interested in measuring the position of the spindle thrust collar, it is desirable to locate the pickup coils as close to this collar as possible in order to avoid possible differential expansion errors. In an actual installation a soft iron disc bolted to the end of the shaft rotates between the two coils, and any axial motion of the rotating disc with respect to the station coils is recorded.

The instruments described above should not be considered as a standard set. Also, the name "Supervisory Instrument" should not be reserved for just these four units. It is quite conceivable that instruments with different functions or modified function of those listed above may be desirable or even needed in the future, and the choice of instruments should be governed by the conditions of service. Considering the needs of an average commercial installation, the above instruments are at the present time considered most desirable from the standpoint of quick starting and safe operation.

Usefulness of these instruments is of even greater scope than implied in the preceding discussion. Practically all of the instruments can be, and some are, equipped with an alarm circuit with limit contacts. The contacts are set for values beyond which sustained operation is considered unsafe. Thus, if any of the above measured functions exceed the set limit, an alarm is sounded warning the operator of the existing condition. In this way an additional automatic safeguard is provided.

While the addition of supervisory instruments cannot be considered a substitute for intelligent operation, it is a definite step toward a better control.

Finally, it should be emphasized that the addition of such equipment as the shaft vibration meter and spindle position meter does not presuppose that a failure or accident will develop. On the contrary the principle value of these instruments is realized by the fact that another step is being taken in the direction of greater plant safety, the importance of which is fully appreciated by power plant engineers. Furthermore, while it is true that equipment insurance acts as a buffer in time of trouble, any relatively small investment, in an instrument whose function is to forestall such trouble, may eliminate costly time delays and do much to maintain the smooth uninterrupted service demanded from the modern power plant.

CORRECT VISCOSITY

In buying oils, be sure they contain no animal fats. Under ordinary conditions an oil having a viscosity of not less than 200 at 100 deg. F., and a low cold test, is found to give the best results. Sometimes, however, operating conditions are severe and the rings may leak. Under these conditions, an oil with a viscosity of 450 or 500 may be necessary.

Neither oil color nor density signify as specific properties in the selection of a lubricant, for, when light, heavy or medium oils are mentioned, they are concerned only as to viscosity. Light means low viscosity and heavy means high viscosity. Excessive friction may result from the use of an oil of either too high or too low viscosity. Too high a viscosity will give a good oil film, but the friction in the oil itself will be excessive. If the viscosity is too low the oil film may be broken.

All lubricating oils should be filtered before use and the oil should be used as thin as possible to retain a perfect film. If this procedure is followed, your lubrication problem is practically solved and will go a long way toward eliminating carbon deposits.

By Anthony A. Fette
Consulting Engineer, Cincinnati, O.

As a result of a thorough study of results obtained in plants depending on purchased electric power and those generating their own power where the essential equipment, testing and metering devices were present, the author of this article readily admits that in a large number of cases purchased power has resulted in a saving to a concern changing from making to buying power, but, he claims, it is also true that in almost as many cases changing to purchased power was a serious mistake. Data presented in this article were obtained from the records of an institutional plant which first generated, then purchased, then generated its own electric power with results decidedly in favor of generation when all steam was used economically

Institution Benefits By Generating Power

WHETHER a plant should make its own power or buy it has been a perplexing problem to many plant owners and operators. On one hand we have the advocates of purchased power who show very convincingly that it is best to stop operating a power plant and buy power. These men have something to sell, and to sell it they must be convincing. On the other hand, the engineers in the plant are in favor of continuing to make power, but many of them are doing things rather than talking about it and are unable to show in a convincing manner that the plant is saving money by making power.

Thus we have plant owners discarding good generating equipment and throwing good operating men out of work with the idea they will save money. Many times they find that the net result is a loss of money. They find it takes almost as much money for fuel for heating alone as it did for both heating and power generation, and they have a large bill for power to pay in addition. The large saving which they were to make by doing away with power plant labor just doesn't turn out that way.

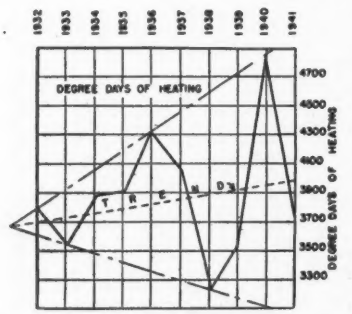


Fig. 1. Heating requirements of Cincinnati plant in degree days over a 10-yr. period

Much of the lack of information on power plant costs is due to the fact that careful bookkeeping is not practiced. The plant may be without steam and electric meters and other instruments and equipment with which to gather operating data. Oftentimes the meters are in place but are not used because they are out of order. No responsible plant manager would think of buying electricity without metering it, or buying paint, iron, nails, or any other commodity without knowing he was getting the amount paid for. Yet many plants are run for years without knowing how much electricity, steam, hot water, ice and heating of the building is costing.

In the case covered in this article, everything was measured and proved. Nothing was left to guesswork and where an estimate was needed it was always conservative and based on good engineering practice and knowledge. Changes were made one step at a time and each worked out with very little cash outlay. Every cent spent was returned almost immediately and is still paying dividends. Good engineering principles plus common sense were all that were needed or used. Knowing what to do, plus how to do it, plus having the initiative and courage to sell the idea to the heads of the institution turned the trick.

The management had to be convinced that the changes proposed could save money. Many men know what should be done but don't stick long enough to the job of selling the idea to their superiors. Too often they give up.

The proof of what was done and what it saved is summarized here from data complete in every detail, and no statement is made which cannot be proven by actual recorded figures.

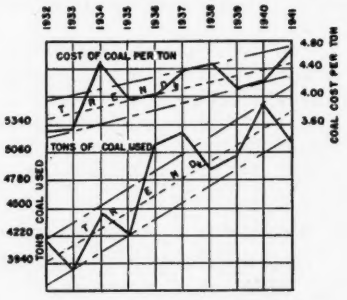


Fig. 2. Coal consumption and cost

Actions Taken and Savings Resulting

The plant originally had two 265-hp. box header water tube boilers, stoker fired, and two 100-kw. engine generators which provided direct current for all power and lighting uses in the buildings. A 5-ton ice machine was used. Later additional buildings were constructed and a 300-hp. h.r.t. boiler installed. At this time the engine generators were discarded and all power purchased from the local utility. The boilers were used only

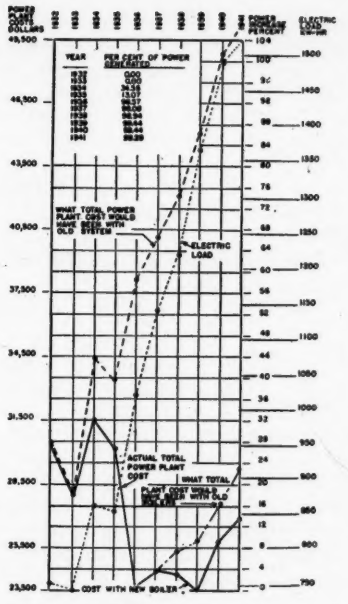

YEAR
PER CENT OF POWER GENERATED
ELECTRIC LOAD
WHAT TOTAL POWER PLANT COST WOULD HAVE BEEN WITH OLD SYSTEM
ACTUAL TOTAL POWER PLANT COST
WHAT TOTAL PLANT COST WOULD HAVE BEEN WITH OLD BOILERS
COST WITH NEW BOILER

Fig. 3. Curve of total plant costs compared to per cent increase in electric power generated

for heating, laundry, cooking, and similar needs. A 30-ton electric driven ice machine was also installed.

Steam was necessary, even in June, July, August and September, when no heating is ordinarily required and this plant used an average of 188 tons of coal per mo. in 1932 and 155 tons per mo. in 1933 during these months, although no electricity was generated. This meant that a power plant crew was necessary and that the overhead or operating costs of the boiler room was practically as much in summer as it was in winter. The amount of electric power required was about as much as during the winter months. An engine generator was purchased as an emergency standby after a rather embarrassing power outage, but this unit was not operated.

The stokers and boilers were in bad shape; many of the electric motors not operating properly, elements were gone out of steam traps, and the plant as a whole badly in need of repairs. The cooling water from the ice machine was being discharged into the sewer, thus making an unduly high water bill. To sum it up, the plant was in a very poor shape physically and probably the operation matched the physical condition. No steam meters were installed, so it is impossible to tell what the boiler efficiency was.

The first move was to get the steam traps working and make the necessary repairs — the repairs which should have been a matter of routine. Then it was decided to start generating power. This step was made a matter of simple economics. The reason it is more economical to run steam through a steam engine or turbine and use it for heating than it is to use it direct is simple and based on a fundamental law of thermodynamics. When we heat water in a boiler, a teakettle, or an open pan, it forms water vapor or steam. This steam is formed at around 212 deg. F. and when this steam is formed, 970.4 British thermal heat units are taken up by it. Of course, the change of any liquid to a gaseous state is always accompanied by the gas picking up heat. This principle is used in refrigeration, and other ways. When water is heated in an open pan, this steam escapes into the atmosphere. The steam in a teakettle comes out the spout. Since the spout constricts the easy flow of steam, as a nozzle on a hose constricts the free flow of water, it builds up a little pressure and the steam almost shoots out in a stream. If the teakettle is so equipped, it blows a whistle.

A boiler is an oversize teakettle and the spout is very much constricted so that the steam comes out at a high pressure. This high pressure is accompanied by high temperature so that steam at 150 psi. has a temperature of over 366 deg. F. This steam has had latent heat added to it by the fire under the boiler and of course carries this latent heat with it. This heat can be recovered and is the basis of all steam heating systems. Heat is measured by British thermal units, just like weight is measured in pounds. Steam at 150 psi pressure and over 366 deg. F. temperature, contains 1195 British thermal units or B.t.u. This is the sum of the heat which was in the water delivered to the boiler, plus the heat added to it as it increased in temperature and pressure to 366

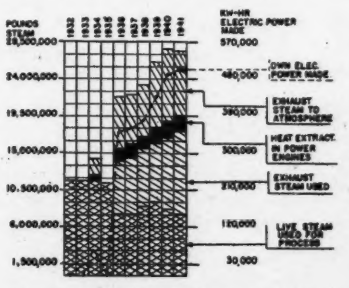


Fig. 4. Distribution of steam load for different services during summer season only

deg. F., plus 970.4 B.t.u. latent heat picked up when it expanded into steam. As you see, most of the heat was picked up when the water changed to steam, and can't be lost until the steam changes back to water and gives up its latent heat.

Pressure Changes

When a steam engine runs, the steam changes pressure from boiler pressure to a predetermined exhaust pressure. It is still steam, however, and still contains most of the heat it contained when it entered the engine. It is started at 150 psi 366 deg. F. temperature and containing 1195 B.t.u. total which includes 856.5 B.t.u. latent heat, it may come out of the engine at 10 psi pressure, 240 deg. F. temperature and still containing 1160 B.t.u. of which 952 B.t.u. is latent heat. Since the pressure is usually reduced for heating, laundry, cooking and other similar uses, the steam when it comes from the engine is "practically as good as new" and may be used for these other purposes. In short, steam can be run through an engine to generate electricity and still retain about 90 per cent of the heat it had when it was admitted to the engine. I might add that in large central stations where there is no use for the exhaust steam, it is allowed to expand fully—that is, lose all its pressure down to the vacuum in the condenser.

These facts being known, the plant started to make power by running the steam engine which had been standing idle. This in itself was quite a job, but, after the engine started running, 297,178 kw-hr. of electric power were generated at a cost of 9.15 mills per kw-hr. and 563,134 kw-hr. purchased at a cost of 15.51 mills (1.55 ct.) for the power purchased.

Engine Generators Installed

The answer to this was to purchase two used engine generators of a larger capacity so that more of the power could be generated. The story of these engines is this: they cost completely installed, $16,529.13 and in 6 yr. saved $107,-144.50, or a yearly saving of $17,-857.41, a yearly return of 108.03 per cent on the investment. They ran the cost of electric power down from 15.51 mills (1.55 ct.) to 2.35 mills (0.00235 ct.). I might add that if instead of used generators, new generators had been installed they would have paid for themselves in about 3½ yr. The used

equipment paid off in less than a year.

The heating and process steam service was not deteriorated in any way by this generation, but was considered better than ever by the people in the buildings. This can be accounted for by the fact that exhaust steam is cooled to the point where it is about ready to give up its latent heat in the radiators, which takes place rapidly, releasing 970.4 B.t.u. per lb. almost at once.

Another item of equipment which engaged the engineer's attention was the 30-ton electric ice machine. It was necessary to have a standby for it so another 30-ton machine was bought, only this one was a steam driven machine. This machine effected a saving totaling $13,825.72 in the next 6 yr. or $2912.86 per yr. The cost of used steam driven ice machine and reconditioning totalled $1978.06, giving a return on the investment of 147.56 per cent.

By making electric power, $107,144.50 was saved by the plant in 6 yr., due largely to the fact that most of the exhaust steam could be used for heating or process.

Cooling Tower Corrects Water Waste

The practice of running city water through a cooler on the ice machine and then to a sewer was a waste which was corrected by installing a cooling tower to cool the water so it could be re-used. This installation cost $1036 and cut the water bill from $3127.56 per yr.

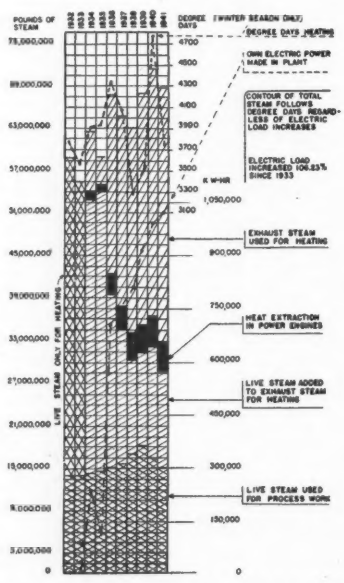

POUNDS OF STEAM
DEGREE DAYS (WINTER SEASON ONLY)
DEGREE DAYS HEATING
OWN ELECTRIC POWER MADE IN PLANT
CONTOUR OF TOTAL STEAM FOLLOWS DEGREE DAYS REGARDLESS OF ELECTRIC LOAD INCREASES
ELECTRIC LOAD INCREASED 106.53% SINCE 1933
K W-HR
EXHAUST STEAM USED FOR HEATING
HEAT EXTRACTION IN POWER ENGINES
LIVE STEAM ADDED TO EXHAUST STEAM FOR HEATING
LIVE STEAM USED FOR PROCESS WORK
LIVE STEAM ONLY FOR HEATING

Fig. 5. Distribution of steam load for different services during winter season only

to as low as $1071.24 per yr., resulting in an average yearly return on the investment of 150.64 per cent. The total saving on the cost of water was $10,534.52 in 6 yr.

A new 275-hp. bent tube boiler replaced the h.r.t. boiler which brought the evaporation up from 8.44 lb. of steam per lb. of coal to 10.33 lb. of steam per lb. of coal, thereby making possible the reduction of the coal bill by $2204.91 per year has been the latest move in this plant. The new boiler has operated only 67.16 per cent of the time. This boiler, if it were used continuously, would return 36.5 per cent on the investment, or pay for itself in 2 yr. and 9 mo. This boiler was tailor made to fit right over the old underfeed stoker.

Steam Used Only for Process Work During Summer

During the summer months no steam, either live or exhaust, is required for space heating in the buildings but considerable is used for process, as shown by the diagram Fig. 4. What live steam is used is reduced in pressure, under present practice, but no live steam is used where it is possible to use exhaust steam that would otherwise go to waste.

The pattern of steam distribution during the winter months is considerably different from that of the summer, as indicated by Fig. 5, for during these months the plant finds use for all the exhaust steam.

In this institution, 60 deg. F. outside temperature is the dividing line between supplying and shutting off space heating, and degree-day calculations are based on this temperature instead of the 65 deg. commonly used as a standard. The results obtained indicate that the heating steam requirements follow the contour of the degree-day curve with greater accuracy than when 65 deg. is used as the basis.

In making these calculations, the average daily temperature as reported hourly by the Government Weather Bureau is used for the day. This average is subtracted from 60, if below that figure, and the difference is recorded as the degree-days for that day. The degree-days for the month are based on the number of days the average temperature is below 60 deg. rather than the number of calendar days, the calculation being as follows:

During one April the Government record showed an average temperature of 52.6 for the entire month. There were 20 days when the average temperature was less than 60 deg. Those 20 days averaged only 47.35 deg. and were the only ones considered for that month.

Degree-days for the month $=$ $(60 - 47.35) \times 20 = 253$.

Cost of Generating Electric Power

By a test it was found that it required 40 lb. of generated steam to supply 1 kw-hr., and this 40 lb. of steam resulted, during the winter season, in an estimated 5 per cent of the heat being used for auxiliary purposes — pumping and heating feedwater, stoker operation, and the like—10 per cent of the heat was converted into power by the engine-generators, and the remainder all carried with the exhaust to the heating and process systems. In making rough estimates, it is customary to charge 10 per cent of the heat going to an engine generating power and 90 per cent to the exhaust steam heating system, when all this exhaust steam is used for this purpose.

The method of calculating the cost of generating electric power in this plant is as follows:

Kw-hr. generated $\times$ 40 $=$ lb. steam for power.

Lb. steam for power $\times$ 0.10 $\times$ 1.05 $\div$ lb. steam per lb. coal $=$ lb. coal chargeable to power generated.

Total cost of coal chargeable to power generated $\div$ kw-hr. generated $=$ cost per kw-hr. of power generated in winter.

In the summer months, the exhaust steam to atmosphere is also charged to electric power. The power cost averages 4.29 mills per kw-hr. in summer, 1.49 in winter and for the entire year the average is 2.35 mills per kw-hr. which is arrived at by dividing the total power cost per year by the total kw-hr. generated. Exhaust steam to atmosphere over the 6-yr. period averaged 28.71 per cent of the total steam generated in summer, but in winter all the exhaust steam was used.

As a result of better management and the installation of more efficient steam generating equipment, the evaporation was increased over the period represented by this study from 8.67 lb. steam per lb. coal in 1934 to 9.36 lb. in 1941, or approximately 8 per cent. With the new boiler operating continuously at highest efficiency and other units taking the swing in the load, records show plant evaporation of 10.33 lb. steam per lb. coal.

Treatment of Rapidly Changing Feedwater

By KURT ILLIG
Power Engineer
Filer Fibre Products Co.

Drawing its boiler feedwater supply from a small lake into which industrial wastes from several plants are discharged, the Filer Fibre Products Co. of Filer City, Mich., is confronted with the problem of treating water having rapidly changing chemical impurities and has accomplished satisfactory results with a hot process softening system using controlled quantities of lime, soda ash, salt cake, phosphate, and sodium aluminate Nos. 610 and 78

WHEN QUESTIONED about water treating in our plant, I frequently answer, "Our water is almost as hard to control as the wind". Though this reply usually brings a look of confusion to the interrogator's face or that peculiar expression some folks have when they entertain mild doubt of one's sanity, nevertheless, my facetious reply is not so far from the literal truth as it would appear to anyone not acquainted with conditions at our source of water supply. It is no exaggeration to say that we have a different raw water to treat every time the wind blows from a new direction.

This condition is due to the small lake, which is our water source, being contaminated with several different kinds of industrial waste discharged into it by plants located along its shore. If you'll glance at the accompanying map, you'll see that our plant is located a few hundred feet from the west shore of Lake Manistee. This is a small body of water about 5 sq. mi. in area, fed mainly by the Big and Little Manistee Rivers, and with an outlet, known as the Manistee River, which flows into Lake Michigan. You will also see that north and east of our plant are other manufacturing establishments whose plants are located in close proximity to the lake. Two are salt refineries, two others are chemical plants, and one is a forging plant. All empty industrial waste into the lake in sufficient quantity to affect measurably the quality of the water. Since there is no perceptible current and the movement of water is quite slow, a condition of pollution builds up around each plant. When the wind is strong from the north, east, or south, we get the effect of this pollution at our water intake pipe, and a different water condition for each direction of the wind.

This makes it essential to check our boiler water much oftener than would be necessary in the case of plants having a fairly constant condition of their raw water. We test our treated water every 2 hr. Our returned condensate and raw water at the intake are tested once a day. Any marked deviation from the analysis we have set as standard for our treated water is compensated for by proper adjustment in the proportions of different chemicals used.

Our plant is a standard paper mill with a capacity to produce 30,000 tons of kraft pulp and paper per year. It can consume more than 50,000 cords of pulp wood per year. During the past 2 yr. we have been operating 24 hr. a day, at capacity practically all the time. The water treating equipment described in this article treats only the boiler feedwater used for our power plant; it is not concerned with the process water used in the mill. So, before describing the water treating system which we have found so satisfactory, let us take a look at our power plant and its requirements. Here is the equipment:

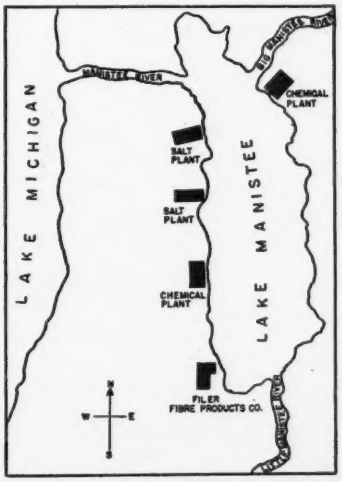


Fig. 1. Map showing location of industrial plants on the shore of the lake

Boiler No. 1. A Combustion Engineering boiler, with a maximum production of 90,000 lb. of steam, has back water walls, is fueled by a Raymond pulverizer, equipped with Hays combustion control.

Boiler No. 2 and No. 3. Badenhausen. Capacity, 45,000 lb. of steam. Fired by Taylor stokers.

Boiler No. 4. Kroeschell boiler. This is a hand-fired auxiliary, using bark from the pulp wood for fuel.

Boiler No. 5. Wickes boiler, 500 hp., operated by waste heat from the Goodell recovery system.

These boilers generate an average of 3,350,000 lb. of steam per day, providing steam power for operating machinery in the entire plant. These boilers supply three steam turbines, which in turn operate one 1500-kw. Westinghouse generator and two 750-kw. General Electric generators. These take care of all of our electric power requirements, the average consumption being 60,000 kw-hr. per day. This information will convey some idea of the size and capacity of our power plant and the demands upon it.

Water Treating Process

Up until 1941, boiler feedwater was treated with a small standard type hot process softener. Installed more than 10 yr. ago, this equipment was not adequate to do the job required for present capacity demands. Therefore, it was decided

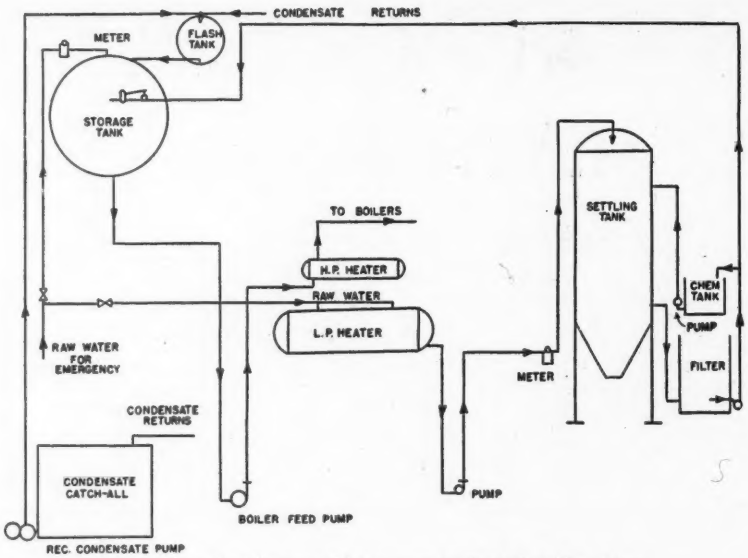


Fig. 2. Water flow diagram of hot process feedwater treating system

to install a complete new water treating system, and in July, 1941, this was done. The equipment selected was that recommended and manufactured by the Graver Tank & Mfg. Co., Inc., of East Chicago, Ind. The hook-up is shown in the accompanying flow chart.

Chemical Flow Is Metered and Controlled

Raw water is preheated in a low-pressure heater, pumped from there into an 8000 g.p.h. settling tank. An average time of 1 hr. is required in the settling tank. Chemicals are mixed in a 5 ft. by 4 ft. 11 in. chemical mixing tank and pumped into the settling tank. Flow of chemicals is metered and controlled so that the chemical mixture is in proper proportion to the flow of untreated water into the settling tank. Lime, soda ash, salt cake, phosphate and sodium aluminate (Nalco No. 610 and Nalco No. 78) are the chemicals used. Proportions of these ingredients are varied to meet the daily or even hourly requirements, as revealed in tests of treated water. From the settling tank the water is pumped through the pressure filters, and from there to the high-pressure heater and direct to the boilers. The condensate is returned to a sump and is pumped back into the storage tank.

The heart of every water treating system is the chemical proportioning and mixing apparatus. This is especially true with us, since the frequently changing conditions of our raw water make it essential to vary the proportions of chemicals used in the mix on an instant's notice. The equipment in our new system enables us to do just that. The Graver proportioner automatically controls the flow of the chemical mixture into the settling tank, keeping it in exact ratio to the volume of raw water being treated. At the same time we can almost instantly vary the proportion of any ingredient in the mixture by a simple manual adjustment. Also, we can quickly change the quantity ratio of the chemical mixture to the volume of raw water. These changes must be made quite frequently in our plant. They are based, of course, on the condition of treated water, as shown by tests made every 2 hr. The fact that adjustments can be made quickly and easily is very helpful to our particular requirements, and particularly so because once an adjustment is made, the proportions are positively maintained by metered control. Besides improving our operating efficiency, and providing better average water conditions in our boilers, this new system has reduced chemical costs by more than 50 per cent. There has also been a reduction of scale and adhesions in the tubes.

Daily Recordings of Water Treatment Kept

We keep detailed daily records of our water treating and have reproduced one report for January, 1942, since we thought it might be interesting for others to see how we keep these records and also to indicate the varying treatment requirements which must be met for our water. With our new treating system which functions more satisfactorily, and by constant vigilance in checking water conditions, we believe our power plant is in a position now to go through the trying months ahead with flying colors. We have been told that we are able to maintain a "better than average" condition of feedwater in our boilers, despite the handicap of a raw water supply whose quality is as variable as the wind.

Boiler-treated Water Report for January, 1942

Date	Lb. Lime	Lb. Soda Ash	Lb. Salt Cake	Lb. Phos. No. 29M	Lb. Sodium Aluminate No. 610	No. 78	Gal. Treated	Solids Maximum in Boiler Water, gr. per gal. 1	2	3	5	Average gr. per gal.
1	98	84	..	..	18	..	153,300	93	..	175	..	135.0
2	98	77	..	..	18	..	137,500	190	..	180	..	185.0
3	49	36	..	..	9	..	79,200	68	..	125	..	96.5
4	27	18	..	200	415	..	49,600	..	..	65	..	65.0
5	111	72	50	..	18	15	122,900	60	..	90	35	62.0
6	100	70	..	..	18	..	135,900	132	..	145	50	109.0
7	119	68	..	..	18	..	152,500	275	..	205	110	197.0
8	111	68	..	200	18	..	133,500	160	..	106	65	110.0
9	108	68	..	..	18	..	160,800	205	..	92	68	122.0
10	81	51	..	..	13.5	..	91,100	84	..	85	..	84.5
11	55	33	..	..	9	..	81,500	..	..	175	..	175.0
12	82	45	..	..	13.5	..	122,100	103	126	82	65	94
13	108	52	50	..	18.0	15	143,300	170	115	65	68	97
14	80	40	..	166.5	13.5	..	131,200	127	105	81	80	78
15	106	51	100	..	18	30	152,100	220	122	66	96	126
16	102	46	..	..	18	..	161,200	200	225	95	110	133.5
17	50	22	..	..	9	..	67,000	145	105	..	71	80.0
18	50	22	..	..	9	..	62,100	..	80	..	..	80.0
19	100	41	..	..	18	..	146,800	117	110	47.0	65.0	85.0
20	100	40	50	..	18	15	152,700	125	115	65.0	62.0	92.0
21	100	40	50	150	18	15	123,500	135	130	88	78	120.0
22	150	60	50	..	27	15	165,200	165	105	98	87	114.0
23	50	20	50	..	9	15	145,000	145	88	118	95	111.5
24	100	37	..	..	18	..	96,000	..	105.0	..	..	105.0
25	50	18	50	..	9	15	53,900	..	85.0	..	..	85.0
26	52	18	..	..	9	..	85,900	115	83.0	97.0	67.0	90.5
27	101	35	50	150	13.5	15	135,900	160	84.0	93.0	67.0	101.0
28	97	36	50	..	9.0	15	147,200	135	95	98	75	100.0
29	96	35	50	..	9.0	15	139,200	198	107	121	84	127.5
30	96	32	50	..	13.5	15	131,200	180	118	130	80	127.0
31	48	16	..	..	9.0	..	107,600	138	145	115	..	132.0
Total	2675	1349	650	966.5	441	195	3,767,700					
Inventory	390	725	670	2300	600	1565						

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Boy, What Sherman Didn't Know!

William Tecumseh Sherman is credited with a certain statement regarding war. It was emphatic but, frankly, the General did not know the half of it. Take, for example, the effect of the war upon a poor editor into whose lap a fellow editor suddenly dumps (figuratively speaking) the job of getting out this P.E.&E. Section. True, the departing editor did it for a good cause and the Captain (Dick Morris) is now having a hell of a time sojourning on the Florida gold coast, living in the Miami Beach hotels, swimming in the ocean and getting up at 5:30 every morning; the fact remains, I am the one left to tussle with literary efforts of Pulverizer Pete, his stooge, Atomizer John and many other lesser thorns in the flesh of any editor. Suppose the Captain IS in the Army! He is in Miami Beach, isn't he? He goes swimming every day, doesn't he? And, suppose he does get up at 5:30 in the morning, he has nothing to do except what some major or colonel or general tells him to do. What is his lot compared to mine? I don't know where this guy, Pulverizer Pete is these days—haven't heard from him since I relinquished the job of getting out this section to former editor Morris—but I know I will hear from him as soon as he learns that I am back on the job. Not only will he accuse me of being a nit-wit but he will send in some of his cockeyed articles which, duty bound, I will be compelled to publish. Worse still, I am the one who will have to explain the pathetic decisions of our "Board of Judges" in the prize contests. As a matter of fact, I don't even know where to find these superannuated relics of the Roman law. The report is that they are all trying to get commissions in the (hot) air force.

These are merely a few things that General Sherman never thought about in connection with war. Marching through Georgia may have been what he said it was, but it was duck soup compared to the pickle I find myself in.

So help a poor guy out, won't you? Send me some funny stuff to help me keep up my spirits and some articles that Pulverizer Pete can't knock holes in. If you will do your part I will do my best to keep up my end. Wish me luck.

But I AM glad to be back with you again.

Andrew Kramer.

CONTENTS

Refrigeration Don'ts 94
By O. W. Malarkey.

Let the Scale Fall Off 95
By Rembert Ray.

Pushing the Patois Around 96
By Charles H. Jennings.

A 50-Ton Baby 59 Years Old 96

Longer Life for Electrolytic Condensers 96

The Why, When, Where, What and How of Flow Meter Installation 97
By W. C. Bennett.

For Better Pipe Bending 98
By W. F. Schaphorst.

Power and Steam Supply in a Small Plant 99
By G. H. Kimball.

What a Mistake Is Worth 99
By George Holman.

Jack Speeds Weld Tests 100

A Weld In Time Saves $57 100

Questions and Answers 101
Any Old Timers Know About Hot Air Engines?
W. B. L. Needs Dope on Making Templates.
A Trap Question for Trap Experts.
Should He Raise His Condenser Pressure?
Preventing Sweat on Cold Water Lines.
Vibration Tolerances.
If the Brine Pump Stops?
Slag and Spalling Mean High Furnace Maintenance.
Should the Heating System Be Drained?

Letters and Comments 104
Four A. W. Kramers Straighten Out a Family Affair.
Forced Draft Requirements—Get Joe Steamed Up.
What the Operator Wants to Know.
Spending Money Like Water.
Avoidable Waste.
Feeding Boiler Compound.

How Would You Do It? 110

Making Your Globe Valves Last Longer 112
By M. S. Palmer.

Shop Talk 114

Chemical Warfare Agents 116

A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

Refrigeration Don'ts

By O. W. MALARKEY

EXPLOSIONS of vessels used in refrigerating systems which release large quantities of ammonia, and result in loss of life and extensive property damage are becoming increasingly rare. This is due to better standards of pressure vessel construction and the replacement of vessels that were built 20 or more years ago and now known to have been of unsound construction. There remain, however, the numerous minor and unpublicized accidents which result in considerable economic waste as represented by the spoilage of goods caused by lack of refrigeration and/or absorption of ammonia fumes; and the loss of ammonia or refrigerant from the system.

In many plants the operators indulge in hazardous practices, such as, charging ammonia into the suction line of the compressor; using a blow-torch to rapidly rid a vessel or coil of ammonia; tightening flange bolts, etc., while the parts are under pressure; disconnecting pipe lines without first making certain that *all* ammonia has been removed; etc.

These practices can, and have, caused ruptures accompanied by the release of sufficient ammonia to overcome the operator or any other persons unable to escape from the fumes, and in public buildings, cause panic. An additional hazard is also present in that if the ammonia and air are in the correct proportions a combustible mixture will be formed and will explode in the presence of open flames or other means of ignition. Several disastrous explosions have been attributed to this condition.

We Frown on This Practice

Charging a system through the compressor is a practice that should be frowned upon, as even a machine equipped with safety heads cannot handle a large slug of liquid and a cracked cylinder or cylinder head may result. A connection provided at the liquid receiver and the charge of ammonia introduced through the evaporating coils will greatly lessen the possibility of damage to the compressor from liquid.

Ridding sections of a system of ammonia is best accomplished by the use of hot water. The application of heat by this method will not cause excessive pressure and temperature as will the use of a blow-torch.

Tightening bolts or disconnecting pipe lines while parts are still under pressure, before making certain that all ammonia has been removed, is a decidedly risky undertaking and has been the cause of many accidents. Utmost precautions should be taken in making repairs of any kind to prevent the breaking of parts and escape of ammonia.

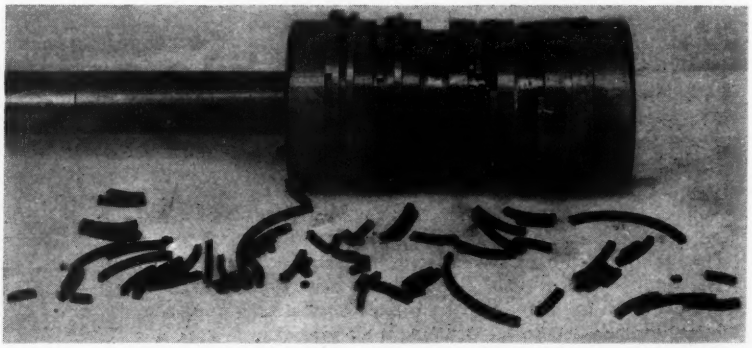


Fig. 2. A piece of broken valve spring which worked its way between the piston and cylinder wall did this to the piston and piston rings of a carbon dioxide compressor

When withdrawing the ammonia charge, care should be taken that the weight of ammonia in the cylinder or drum does not exceed the amount specified on the shipping tag, and, the container should be stored away from heat. These shipping drums are provided with temperature and pressure relieving devices that will allow boiling ammonia to escape, with its resulting hazards, if the safe limits of the container are exceeded. The same precautions against overfilling should be taken when the charge is shifted from one part of the system to another, as is sometimes necessary when making repairs.

Proper provisions should be made for the expansion and vaporization of the liquid in the event of a rise in pressure caused by an increase in temperature. There have been numerous instances where rupture of vessels and piping have occurred because an excessive amount of liquid ammonia had been stored in a confined space.

A system equipped with the proper protective devices is unlikely to experience an accident as a result of little or no condensing water. There are many installations, however, not equipped with pressure relieving devices or high-pressure cut-outs, and in the event of loss of water, excessively high pressure resulting in rupture may occur.

Not only should every vessel that may hold an appreciable amount of liquid in the system, and that may be isolated, be equipped with a relief valve but the cooling water supply should be ample with no possibilities of hot water supply systems generating steam and backing through the condensers. High-pressure cut-outs are desirable, as it is annoying, expensive, and not unusual in many plants to find the charge of ammonia blown out of the relief valve due to the loss of, or to too hot, cooling water.

Fig. 1. An acetylene torch used to cut a connecting pipe caused over pressure in this ammonia receiver which failed along a welded seam. Five men were injured, three of them fatally

Improper Coil Supports

There have been numerous cases of failure of evaporating coils improperly supported in cold rooms, or, not sufficiently protected from dropping ice cans in brine tanks. Heavy ice coatings on evaporating coils not only put undue stresses, on improperly supported pipe and fittings which may result in rupture, but as the ice acts as an insulator the efficiency of the coil is materially reduced.

Carelessness in dropping ice cans on expansion piping in brine tanks with the resultant breaking of pipe or fittings has many times caused the loss of a quantity of ammonia and the complete loss of the brine. The cost of providing necessary

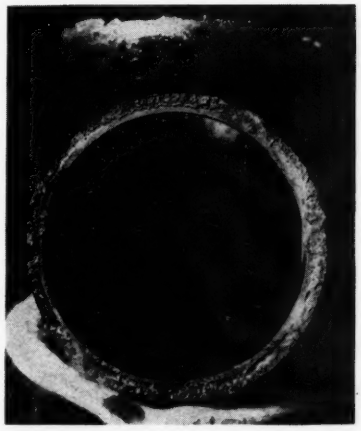


Fig. 3. Poor fusion in this welded seam in a bypass line caused $20,000 damage in a refrigerating plant

protection to the piping would have been negligible compared to replacing the brine and ammonia lost.

The importance of maintaining the proper density and alkalinity of brine cannot be overemphasized. A weak solution of brine will result in a freeze-up of the tubes in a brine cooler or the formation of ice on the pipes of a tank coil, with possible rupture and a certain reduction in heat transmission. It is important that the brine solution be kept alkaline. If it becomes acid, which it has a natural tendency to do, the corrosion of coils, ice cans, etc., will be rapid and require too-frequent replacements.

Corrosion

Internal corrosion of piping and vessels containing ammonia is unusual but not non-existent. When this condition does occur it is usually caused by using a poor grade of lubricating oil in the compressor. This when subjected to high discharge temperature decomposes, becomes acid and attacks the internal surfaces.

External corrosion of ammonia equipment is a common occurrence and has caused many accidents. Vessels and piping are often in damp and wet locations resulting in rapid deterioration. The best preventative against this condition, if the equipment cannot be relocated, is frequent cleaning by wire brush, and painting with moisture resisting paint which will materially lengthen the life of the apparatus.

In the operation and maintenance of ammonia refrigerating systems, recognizance should always be given to the following facts: Ammonia pressure increases at an alarming rate with an increase in temperature and the pressure may exceed the safe limit of the container unless proper protective devices are afforded. Ammonia is an extremely noxious gas and its escape may result in loss of life, health impairment, or a panic in public buildings. Ammonia under certain conditions may produce a combustion explosion unless proper ventilation is provided. Ammonia leakage will produce an economic loss of many commodities.

Let the Scale Fall Off

An inquisitive engineer discovers that not all scale can be removed by chemical means, but that nature with a bit of assistance will do a fairly good job for scale cannot stand the expansion and contraction encountered by alternate drying and wetting

By REMBERT RAY

If you have one of those worrisome and difficult scale problems, stop worrying and let the scale fall off. It seems that the harder you fight the scale the tighter it hangs on.

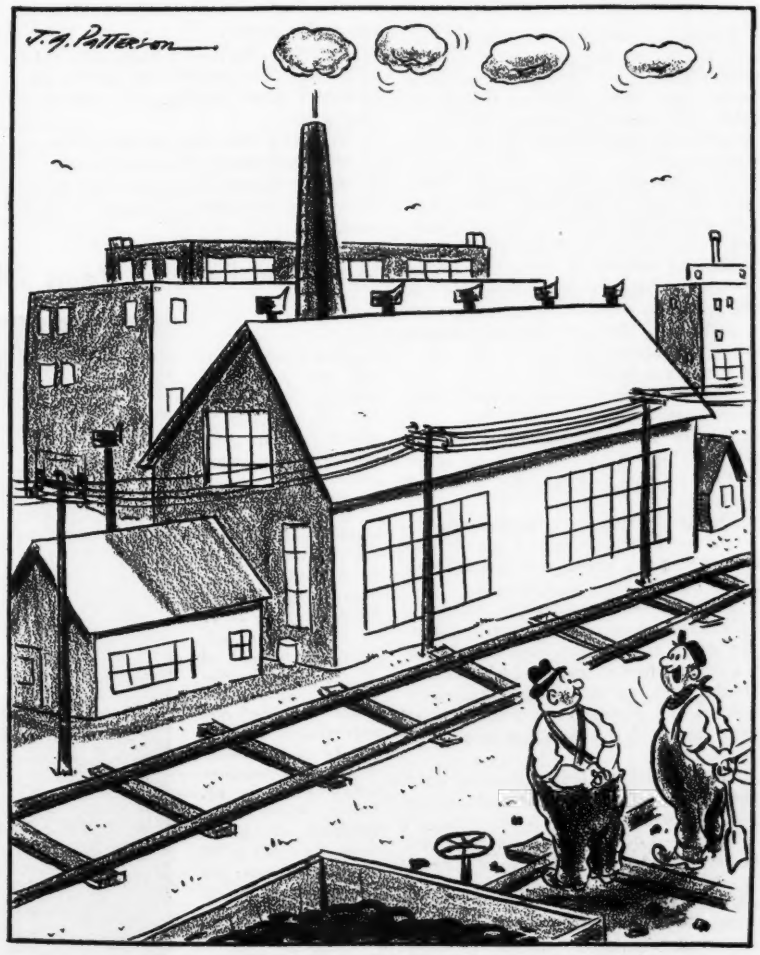
Several years ago, before I came to this plant, gas engines were installed with an open cooling system for the jacket water. Scaling of the engine jackets and serious engine trouble developed. The engine jackets were cleaned out, with considerable difficulty under emergency conditions, and the open jacket water system was converted to a closed system.

This was accomplished by installing a stack of 2 in. pipes (12 pipes wide and 10 pipes high) in the cooling tower. The jacket pump was connected to this stack of pipes and another pump was installed to pump the water from the pan to the nozzles at the top of the tower.

This eliminated the trouble from jacket scaling since the quantity of make-up water to the enclosed jacket system is very small. As time went on, however, the exterior of the stack of pipes gradually built up with scale and the jacket water temperature gradually increased.

Many attempts proved that it was quite impossible to remove this scale manually. There was no room to work and about the only thing accomplished by the men who attempted the job was considerable practice as contortionists. Then a salesman came along with a material to add to the tower water to remove the scale. To make a long story shorter, these scaled pipes became the guinea pig for more than a half dozen scale removing materials. The results were all the same, but with variations, mostly human, even when log chains were pulled over the pipes to loosen the scale.

Later I decided to use acid (which has been treated or inhibited to reduce its attack on iron). However, the acid



"Ya got to hand it to Snodgrass—He's gettin' purty good blowing smoke rings since he got his new damper regulator."

went off in smoke so rapidly that 2 bbl. removed very little scale.

Now for some time past I have ceased asking how the various materials are supposed to work or what they might do to the pipes, etc., because we must eventually scrap this layout and build anew with provision for removing scale. The reasonable thing seemed to be to continue using the system s was until hot jacket water threatens trouble, then scrap it.

During winter we operate part of each day one engine only and at reduced capacity. Last winter while looking around to apply economies, I decided that during the reduced capacity period in cool weather it was not necessary to run the engine tower pump and thus a little power could be saved.

This caused the scale to become wet and then bone dry each day. This, with some expansion and contraction, caused the scale to fall off, which restored the original cooling capacity of the coils. All we did was to rake the scale to one end of the pan and shovel out about 10 wheelbarrow fulls.

Pushing the Patois Around

By CHARLES H. JENNINGS*

JITTERBUGS and jive cats are not the only people to use a colorful jargon unintelligible to the uninitiated for welders, too, have a lingo all their own. Below are some of the most common slang terms used in welding shops the country over.

Auto-cracking — Cracking resulting from the weld's own forces and conditions during cooling to room temperature.

Banana weave—A weaving motion applied to the electrode which has the characteristic shape of a banana.

Bubble — Hollow raised section sometimes occurring at the weld crater after the arc is broken.

Diggin-in—Act of obtaining deep penetration.

Dingle balls—Molten particles of spatter falling from the electrode when welding in the vertical and overhead positions.

Doodle berries—See dingle balls.

Drive—Characteristic of an electric arc which has a strong directional force and produces deep penetration.

Fish-eye — Characteristic marking sometimes found on the fractured surface of a tensile specimen consisting of a central flaw surrounded by a bright circular area; surface of flaw is slightly concave and disposed approximately at right angles to the direction of applied stress.

Grapes—Elongated particles of weld metal hanging from the surface of an overhead weld.

Icicles—Localized raised sections on the reverse side of a welded joint formed by drops of molten metal becoming solidified during the process of falling from the joint.

Islands—Isolated patches of slag on the surface of a weld.

*Westinghouse Elec. & Mfg. Co.

Jazz-box—Small size a-c welding transformer.

Kick—Electric shock.

Locked-up-stress — See residual stress.

Residual stress—Stresses remaining in a structure of member as a result of thermal or mechanical treatment or both.

Skip—Discontinuity in a weld.

Snake eye—See fish eye.

Skipping—Act of forming skips in a weld.

Snappy arc—An electric arc which makes sharp crackling sounds.

Spalls—See spatter.

Spatter—Small particles of metal not comprising part of the weld that have been thrown from the electrode or blown from the deposited metal while still molten.

Splatter—See spatter.

Stumbling—Act of unintentionally interrupting the welding arc as a result of improper electrode manipulation, welding technique or conditions.

Volcano—Eruption occurring after the first layer on a multiple layer weld which is accompanied by an explosion and a shower of molten metal, caused by the explosion of gas inclusions in the under layers.

Welder's floss — Coagulated iron-oxide particles which float in the air. Obtained when welding with bare type electrodes.

Welder's silk—See welders floss.

Welder's pliers—Electrode holder.

Worm holes—Elongated gas holes sometimes obtained in deposited weld metal.

Longer Life for Electrolytic Condensers

By J. BUSS*

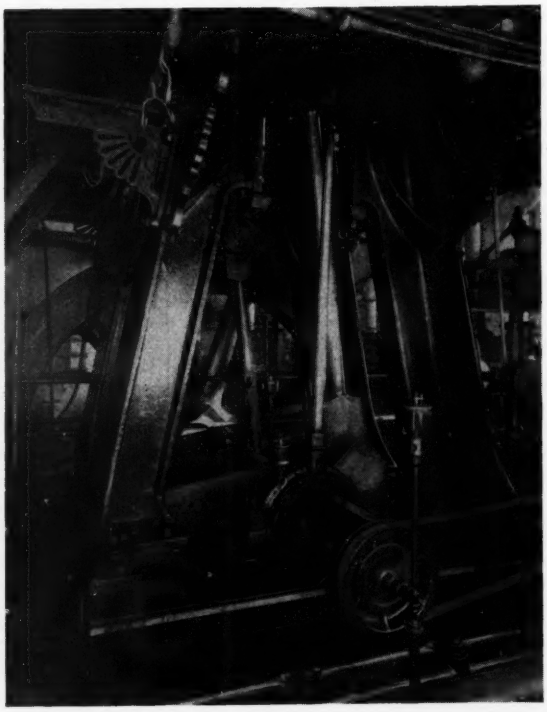
ELECTROLYTIC condensers are used in connection with single-phase motors to provide a split-phase starting cycle. When installed in hot places such as boiler rooms, these condensers have a tendency to dry out and thus become useless. Heretofore, when this occurred, it was usual practice to discard the dried-out condensers and replace them with new ones as they are relatively inexpensive.

Under war conditions, however, electrolytic condensers are difficult to obtain and the failure of a unit may result in considerable trouble. We had trouble of this kind until we found a way of restoring the dried-out condensers to their former effectiveness. In the motor circuit of the damper control there is a 72 mf. electrolytic condenser which some time ago failed as described above. Efforts to obtain a new one met with little success.

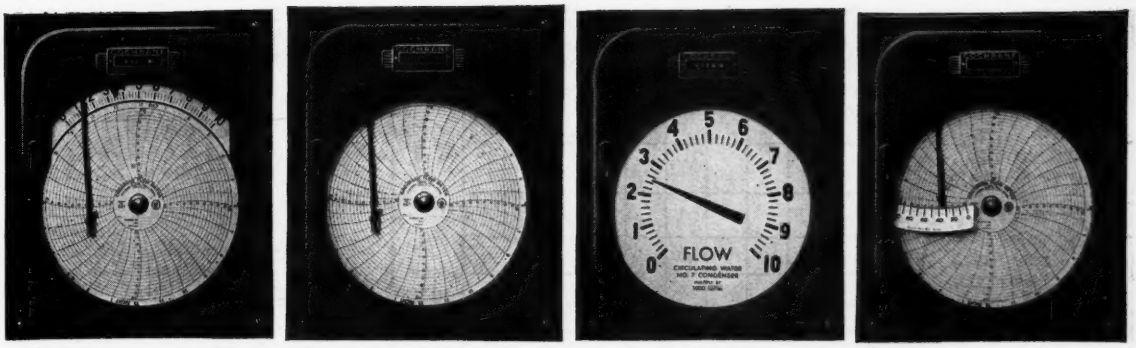
A very small hole was drilled in the casing—just deep enough to go through the casing but without damaging the aluminum foil inside. With a medicine dropper distilled water was added to the electrolyte within. The hole was then sealed up. The result is an electrolytic condenser just as good as new and if it dries up again, the process can be repeated.

*Chief Engineer, Happy Day Laundry, Chicago, Ill.

A 50-Ton Baby 59 Years Old Is Still Working



Installed in 1883, bearing the Arctic Ice Machine Co. serial No. 49 and still in service at the John Morrell & Co. meat packing plant at Ottumwa, Ia., Old "No. 1" is thought to hold national old age honors. It has a 13 by 24 in. vertical double acting compressor cylinder, driven by an 18 by 24 in. steam cylinder and is rated at 50 t. York Ice Machinery Corp. (successors to Arctic) records showed that all but 11 of the earlier 48 machines had been scrapped. G. M. Foster, Morrell's vice-president of operations, then did a bit of gumshoe work. He tracked down the 11 and found they had all been scrapped too —20 yr. ago!



Flow meters are made in many different styles and types. Four of these from left to right are: Recording with an integral indicator (see scale at top of chart); recording only; indicating only; and recording with a pen arm indicator

The Why, When, Where, What and How of FLOW METER INSTALLATION

Part II. How flow is measured and recorded; power available; and the effect of low flows on meter accuracy[1]

By W. C. BENNETT
Cochrane Corp.

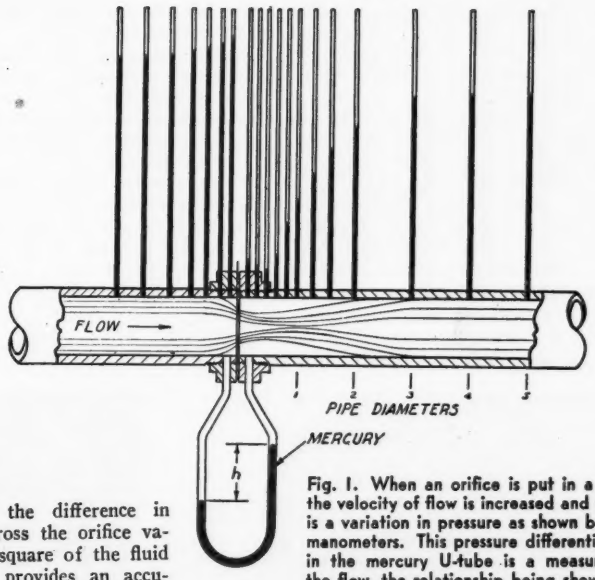


Fig. 1. When an orifice is put in a pipe the velocity of flow is increased and there is a variation in pressure as shown by the manometers. This pressure differential, h, in the mercury U-tube is a measure of the flow, the relationship being shown by the square root curve of Fig. 2

IF THE cross-sectional area of a pipe is reduced by an orifice, or nozzle or Venturi tube, as in Fig. 1, there will be an increase in the fluid velocity at that point and with it a localized drop in pressure. The normal velocity is resumed four or five pipe diameters downstream of the orifice and most of the pressure drop across the orifice is restored.

Because the difference in pressure across the orifice varies as the square of the fluid velocity, it provides an accurate index of the rate of flow. By applying a differential pressure gage across the orifice, the flow can be measured, recorded, indicated and totalized.

Most meters are essentially metal U-tubes or manometers with a mercury seal. A change in flow changes the differential across the orifice and this produces a movement of the mercury.

In a recording flow meter, accuracy depends on how well this mercury movement is translated to a chart record. There is friction to overcome. Power is needed to overcome it and, in the final analysis, the ratio of power available to friction loss will express the accuracy of the meter.

What friction must be overcome? That depends on design and, in some designs, subsequently on maintenance. There may be bearings in the mercury manometer, or, a stuffing box through its wall. Linkages, cams or mechanisms may be interposed in accomplishing the ultimate result of moving the pen. And at last the pen must be pivoted and must bear against the chart.

What power is available to overcome this friction? Only power produced or controlled by the mercury rise and fall, and this mercury movement becomes progressively smaller as the flow becomes less because the rate of flow varies as the square root of the differential pressure.[2] At low flows the mercury movement is small indeed as shown by Fig. 2.

Does this mean that accuracy diminishes as flow decreases? Unfortunately, yes, seriously so unless frictional effects

[1]Part I, Why, When and Where Flow Meters Are Needed, appeared on pp. 88 and 110 of the October issue. Part III, How to Select Primary Elements and the Most Desirable Differential; Part IV, Where to Install the Orifice or Flow Nozzle; and Part V, How to Pipe the Flow Meter, will appear in subsequent issues.

This series of articles considers only practical flow meter use and installation for those reasonably familiar with general theory and construction. For a complete development of the theory and a comprehensive treatment of fluid measurement the author refers interested readers to the publications of the A.S.M.E. Special Research Committee on Fluid Meters. These are available in three separate volumes: Part I on theory and application covers the classification of all types of fluid meters, develops the theory, gives physical constants and meter coefficients and includes an extensive bibliography, Part II describes the individual makes of meters (both primary and secondary devices) in commercial manufacture. Part III covers selection and installation. These are available from the American Society of Mechanical Engineers, 29 West 39th St., New York City, at the following prices: Part I, $3.00; Part II, $1.75; and Part III, $1.50.

[2]EDITOR'S NOTE: The relationship of flow and pressure differential will be referred to in greater detail later. It should be remembered, however, that for a given installation the differential depends only on the flow and orifice diameter and is independent of the type or make of meter. Using a smaller orifice gives a greater differential and a correspondingly greater permanent pressure loss. A larger orifice gives a smaller differential, and consequently a smaller permanent pressure loss but, in general, at the expense of accuracy.

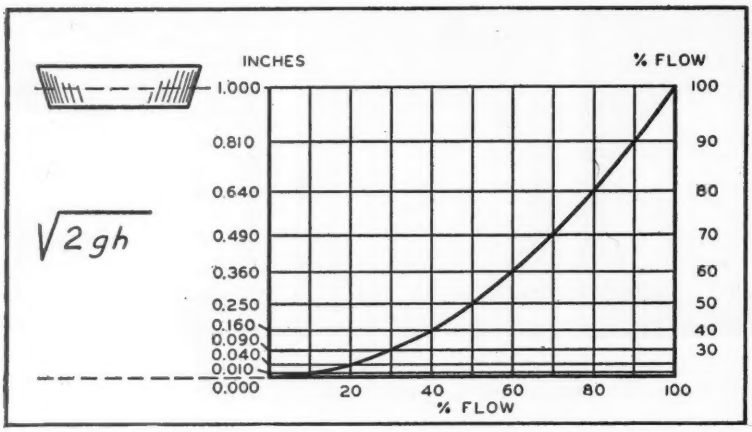


Fig. 2. The differential pressure or head, h, varies as the square of the flow so that at low flows the mercury movement is small

are minimized in the measurement of the mercury movement (that is to say at the manometer) and also unless high power swamps out the frictional load of pen arm pivot and pen point, plus integrators, indicators, auxiliary control pilots or contacts.

There have been many interesting and ingenious head metering designs offered to industry and some of these are still being produced and serve admirably in particular applications. However, for practical consideration, Table I covers all the important industrial types and represents almost 100 per cent of the head meters currently installed.

Selecting Meter Style

Flow meters usually are provided with 12-in. diameter circular charts. Integrators are being specified to an increasing extent and older methods of hand planimetering are being discarded as less accurate and economical.

The incremental cost of the recording versus the indicating only (see illustrations at beginning of this article) should be considered in relation to the installation as a whole rather than in connection with the instrument by itself. When the primary element and the cost of the installation work is added in, the cost of the recording feature becomes a small portion of the total.

To be sure, there is no justification for accumulating a multiplicity of meter data if proper analysis is not to be applied to it. In such cases the recorder should be used merely as an indicator by stopping the chart revolution. Then when some need arises to check operating methods, locate leaks, analyze load trends, the meter can be called upon to produce its graphic story.

When possible, obtain an auxiliary indicating feature, for again at small additional cost you are amplifying the value of the entire installation. The greater visibility of the measurement insures more frequent reading and the meter is only beneficial to the extent that it is read.

Control mechanisms can be incorporated in flow meters to secure rate of flow regulation. Both air operated and electric control systems are available.

Table I. Commercial Types of Flow Meters Listed Alphabetically Under Each Type

Type	Kind	Uniform or Square Root Charts
Mechanical	Diaphragm or Bellows	Square Root
	Float-Operated	Square Root*
	Float-Operated With Shaped Leg	Uniform
	Ledoux Bell	Uniform
	Ring Balance	Uniform
	Tilting U-Tube	Uniform
Electrical	Inductance Bridge	Square Root
	Inductance Bridge Null Method	Uniform
	Variable Resistance	Uniform
Mechanical-Electrical	Float-Operated	Uniform
	Ledoux Bell	Uniform

*Also with cam in pen arm linkage to provide uniform chart.

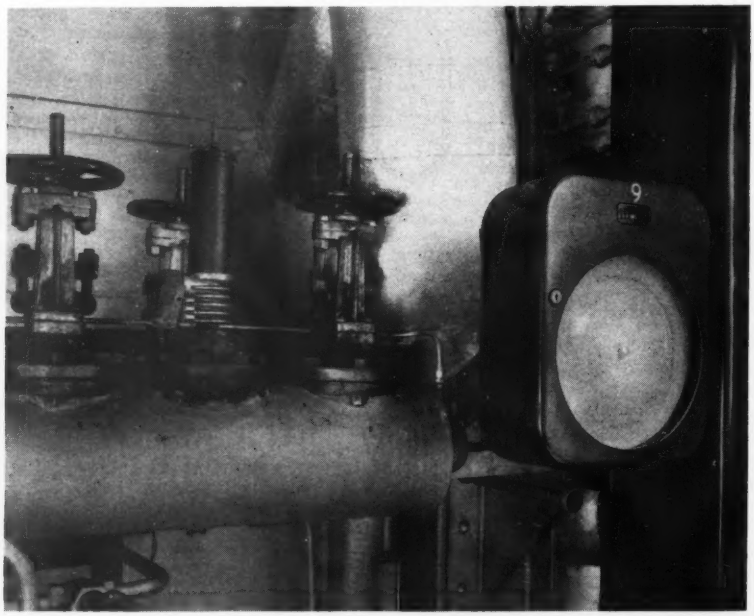


Fig. 3. Liquids whose viscosity makes them unsuitable for measurement by head type meters because connecting lines might clog, are readily handled by area type meters. In this type meter no considerable length of straight pipe run is required, and as shown in this installation, the meter body may be installed adjacent to a valve or fitting. In contrast to "head" meters which employ a fixed orifice, "area" meters employ a variable orifice or restriction. An indication of the flow is given by the area of the opening under a constant pressure differential

For Better Pipe Bending

By W. F. SCHAPHORST

If you ever do pipe bending you naturally want to know the best and most up-to-date way in which to do it. Dry sand is commonly used as a packing for pipe bending, and it is an excellent material for the purpose. The new information pertains principally to the best way in which to pack sand into the pipes that are to be bent.

It is important to pack as much sand into the pipe as can be put in practicably, and there is no better way than via the vibration method. Attach a vibrator to the side of the pipe by means of a chain clamp, and with the pipe standing in a vertical position and with the lower end sealed.

Then, after the pipe is filled and vibrated until it will not hold any more sand by that process, additional sand can still be forced into the pipe by pounding the pipe with a sledge hammer for a short period of time. In other words, use the vibration method to accomplish the hardest part and most of the work, and then finish the job with 20 to 50 blows from a hammer to bring about final settlement.

Power and Steam Supply in a Small Plant

By G. H. KIMBALL

FOR MANY YEARS, the plant discussed in this article had generated all of its power employing 115 v. d.c. for motors and lights. At the time improvements were contemplated, the boiler plant consisted of three h.r.t. boilers 72 in. by 16 ft. and three engine units of 100, 125 and 250 kw.

It was felt that a more economical and modern plant should be developed and the first change was made in the boiler room by installing two water tube boilers. They were designed to carry 200 psi and either boiler was capable of generating sufficient steam to carry the load that the three smaller boilers had been carrying before.

The boilers being installed, the question of improved economy in the engine room arose and steps were taken to see if a modern uniflow engine would not be profitable to install, so that all of the load could be carried by one unit in place of running three as had been necessary at times.

Representatives of the local utility then approached the company with the request that they make a survey of the lighting and motor equipment of the factory as a whole. They offered a proposition to supply all of the power by using motor-generator sets to supply direct current for power and transformers to step down the alternating current at 2300 v. to 115 for lights.

Naturally, they wished to supply all of the power all of the time, but the company felt that since their engines were in good condition during the heating season, it would be profitable to generate enough power by steam to supply the heating system. Very little steam is needed for process work.

By this arrangement, the company made a substantial saving over what the expense had formerly been, but after some years of operation by the new system certain manufacturers of stokers, engines and oil burners felt that still more economy could be had if more modern equipment should be installed. A number of concerns which supplied such equipment were given the necessary aids to survey the plant, consult records of operation and any other important data that was needed.

There were certain features in this plant that made it difficult to interest the company in investing a sum approximating $40,000 for new equipment that would return a saving of approximately 16 per cent on the investment.

First, the operating charges of the power plant were about $30,000 per yr.; second, the period of maximum load was between 8:00 A. M. and 5:00 P. M. The night load seldom exceeded 50 kw. Still the use of some utility power would have to be furnished almost all of the time, and to keep men in the boiler room for this purpose would be too expensive. The large unit that furnished the power for the day load could not be used at night so it was a matter of some sort of internal combustion engine that could be operated by the watchman for the light load periods and also be large enough to furnish power for a 750-gal. electric-driven fire pump.

After a general survey of the plant by consulting engineers had resulted in the above recommendations of saving, the company, without considering a small unit for light load periods, but purchasing utility service up to 50 kv-a. demand, felt that they did not care to make the investment.

Some years before, the utility company had submitted a proposition for supplying steam since one of their boiler plants was in fairly close proximity to the plant in question. This was revived by another engineer, who, at the same time felt that it would be advantageous to purchase electric current at 13,800 v. instead of 2300 as they had been doing.

Purchasing power at this higher voltage would cut the expense considerably, but it also involved the purchase of transformer and switching equipment at an estimated cost of $8000. To use outside steam would not cause much of an investment since the steam company agreed to run their line to connect with the main steam header in the purchaser's boiler room.

Estimate of the total amount of steam needed for a year varied greatly, those of three consulting engineering firms were as follows: 15,400,000 lb., 9,950,000 lb. and 7,713,000 lb. The utility estimated 9,600,000 lb. These figures being for a normal or average year as computed from the plant records of the preceding 5 yr.

It is often found when some new plan is considered in connection with a plant that has operated for a number of years that certain customs and methods have crept in so that finally they are accepted as unchangeable. Where a plant is directly connected with factory buildings, it is often hard to determine just where the employes of the two divisions terminate their duties.

So, while estimating the saving in labor, the engineer may be an old employee and there may be some question about letting him go. And a large amount of equipment remaining in the plant usually has to be kept clean and in reasonably good repair and also in the boiler room where large amounts of rubbish have to be burned. So one man was retained for this and other work there. Also, the steam company wished to have the boilers kept in operating condition. The final estimates of the engineer were as follows:

Labor	$ 2300.00
Superintendence	900.00
Maintenance, Repairs	300.00
Steam	6353.50
Electricity	14,115.10
Total	$23,968.60

It being decided to go ahead with the changes, the expense of the electrical installation was $7755.91, and for the steam installation $1100.63 was spent.

There are features of this installation that are peculiar. Due to operating the engines, it was felt that a flow meter may not be very accurate so a condensate meter was used, although some steam is used that cannot be metered and this feature was made plain to the utility company when connections were completed. The heating company agreed to take the condensate and allow a credit of 5 ct. per 1000 lb. if it were pumped back to their boiler plant. Thus, the condensate runs from the meter to the original return tank where a float-controlled centrifugal pump delivers it back to the heating plant.

For the first year of operation the saving in the cost of electricity over what it would have been under the former rate and deducting 2 per cent for transformer losses was $3784.99 which may be considered a substantial saving.

For steam, the total amount purchased totaled 12,230,300 lb. at an expense of $8005.10. During the past years the expense has either been more or less than this amount due to the difference in degree days of the heating period.

The actual expense for 1941 as compared with the estimates given above are as follows:

Labor	$ 3223.19
Superintendence	900.00
Maintenance, Repairs	752.03
Steam	8209.81
Electricity	14,278.23
Total	$27,363.26

The total expense of operating the power plant for a normal year averaged $34,446. Instead of a saving of $10,000, about $7000 is the result which seems to justify the changes made.

What a Mistake Is Worth

By GEORGE HOLMAN

AN OLD machinist once told me that "one mistake is worth a year's experience." If this were true, then I have had about a thousand years' experience, or rather the equivalent of that much experience. I have made my share of mistakes, and then some. Most of these mistakes did no credit to my intelligence, and certainly were not to be preferred before the experience of even a few minutes.

However, one mistake I made taught me a valuable lesson, enhanced my reputation as a machinist and incidentally resulted in a marked improvement in the efficiency of the machine I was working on—all through no intent of mine.

The job on which I made this particular mistake was the re-babbitting of

the bevel "bull" gear of an eccentric-motion rock crusher. Re-babbitting a gear may sound odd to the ears of most machinists, but not to crusher men. It is literally true. This gear was about 4 ft. across, and was sealed into a gear box at the lower end of the vertical crusher shaft on which it rotated.

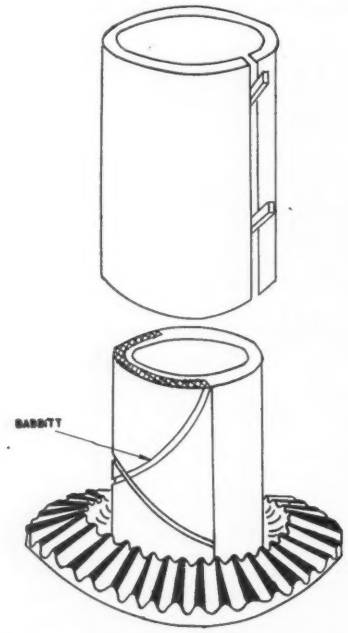
It had a long boss on the inside, or tooth side, of the gear. This boss provided ample bearing surface, and was babbitt bushed inside for bearing against the shaft. There was another babbitt bearing surface on the outside of the boss, extending half way around it, as shown in the lower part of the illustration.

Although of necessity concentric to the pitch circle, this outer bearing surface was eccentric to the bore of the gear. This eccentricity governed the throw of the acorn in the crushing bowl at the top of the shaft.

I had poured bearings before this, but none like this one. I had to do the job after the crusher knocked off on a Saturday noon. On my arrival the foreman, who was going home over the week-end, produced two forms. These forms were simple cylinders split lengthwise.

One form, of the same outside diameter as the acorn shaft, was to be placed inside the boss. The other, which had a slightly lesser inside diameter than the outside diameter of the boss, was to be placed over the boss. To do this wedges had to be driven into the slot, as shown in the upper portion of the illustration. After the form was in place the wedges were knocked out and the form allowed to clamp itself around the boss. That was the way other machinists had done the job, the foreman told me, and left.

With two Negroes whom the foreman left to assist me I lowered the gear and thrust ring on the bottom cover plate of the gear housing. My helpers skidded the gear outside on railroad ties and 40 lb. T-iron. A fire under the gear served the triple purpose of burning off a generous supply of 600-w, melting off the old babbitt and preheating the gear for the pour.



The author forgot to knock out these wedges after placing the form for pouring the babbitt bearing surface on the gear shown below. The result was a better fitting bearing, which gave considerably more throw to the cracking acorn and increased the capacity of the crusher

As the old babbitt ran off and cooled, I picked it up with my pliers and dropped it into the melting ladle. I leveled the gear, set the forms in place and daubed the cracks with a mud made of crumbled asbestos insulation mixed with oil.

By the time the babbitt turned my pine splinter black I was ready. My assistants lifted the pot by means of a 2-by-4 through the bail, while I tilted it for the double pour. Both looked good as the babbitt set.

I did not notice my error until I started to remove the forms. Then I almost fainted. I had forgotten to remove the wedges I had driven into the slot to get the outside form over the boss. On removing the form and checking, I found that the outside diameter was ⅛-in. greater than it should have been had I followed the foreman's instructions.

There were two ways in which I could rectify my error. I could melt the babbitt out, and do the job over; or I could dress off the babbitt with a scraper and rasp or bastard file. I decided on the latter method, and went back to the shop for calipers with which to check for clearance, something I should have done at the start. I was hopefully surprised to find that the boss outside diameter was still $\frac{1}{64}$-in. or so under the inside diameter of the stuffing box-like cylinder it turned in. I cut the oil grooves, and jacked the gear back into place. I ran the crusher for a half hour empty, then put my okay on the job.

I heard no more from the crusher foreman for months. Then one day he came to the shop. "You sure did a swell job on that bearing," he told me. "It has already lasted twice as long as at any time before. The acorn has a lot more throw, and eats that rock a lot faster than we can bring it up the incline. Next time that bearing has to be poured, I want you to do it."

I didn't tell him that it was all a mistake, and to this day he is none the wiser, but I am.

Jack Speeds Weld Tests

To SPEED tests of welds, technicians at the B. H. Leonard Welding School of St. Louis, Mo., and the Midwest Piping & Supply Co. designed the all welded test jack shown by the photograph. It consists of a sturdy frame built around a hand-operated hydraulic jack and is used for making free-bend, side-bend, and back-bend tests on weld coupons. It was made from scrap pieces of steel using Lincoln arc welding equipment.

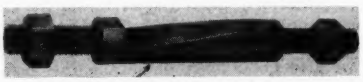
The hydraulic jack used is rated at 8 tons, and the side and top members of the frame are made of mild steel, 6 in. wide and ½ in. thick. The side pieces are approximately 2 ft. long and the top members 9 in. The bottom base plate is 9 in. square and 1-in. thick.

Sturdy welded test jack used in testing side-bend, back-bend and free-bend welds in the testing of arc welding operators on field construction jobs

The male member of the die is 1½ in. by 2 in. by 6 in. The upper end is machined on a ¾-in. radius and the lower end is welded to the upper surface of the jack. The female part of the die also was 2 in. thick and its curved portion is machined on a 1 3/13-in. radius. The lower corners of the female portion of the dies were rounded off as shown.

A Weld in Time Saves $57

WHEN A troublesome noise in a 28 by 32 in. poppet valve engine necessitated tearing it down, the chief engineer found the end broken off from the wedge bolt, about ⅜ in. from the shoulder. On the phone the engine builder said "No wedges in stock and 3 days to make one." That meant 40 per cent of shop production would be held up while the engine was



This wedge was repaired by welding. The location of the break is shown by the arrow

down. The only alternative was to repair the wedge. After heating it to between 500 and 700 deg. F., a stub of chrome manganese steel was welded onto the broken wedge, using P&H Harnimoly, an electrode designed for joining high carbon or alloy steels subject to machining and heat treatment.

After cooling, the stub was turned and threaded, and installed in the engine. At 9:50 p. m., exactly 6 hr. after shutting it down, the engine was running smoothly again. Results: Total shop cost $3.25, including labor and material. A new wedge would have cost over $60 and the engine would have been shut down for not less than 3 days.

* * *

Shasta Dam of the Central Valley Project in California, now under construction, will be the second largest in the world. It will be over 500 ft. high and have 5,000,000 cu. yd. of concrete. Only Grand Coulee is larger.

Questions and Answers

Question No. 196

Any Old Timers Know About Hot Air Engines?

WE HAVE found in the store room a Size 8, Rider Ericcson hot air engine which is in excellent shape. What oil should it be lubricated with, what are its strong and weak points, what power will it develop and is it worth while trying to make use of? W. E. H.

Question No. 197

W. B. L. Needs Dope on Making Templates

WHILE I have considerable data pertaining to pipe work, I can find nothing telling me how to calculate or make a pattern to mark off pipe to make 45 deg. angles, or to join two pipes together to make a branch or wye. It seems to me there must be a formula for marking off the pipe before cutting so as to make what we call a stove pipe weld. Can some reader help me on this?

W. B. L.

Question No. 198

A Trap Question for Trap Experts

FOR SOME time we have been arguing about a question asked in an examination without reaching any satisfactory answer. Can readers help us on this? The question with the examiner's comments is:

"In a large dye house in a textile mill a large tilt trap was put on the line. As near as I could judge it was about 36 in. long and 24 in. high. The fitters had to travel by train to do the job. They worked all day on it and as night fell the job was completed and the fitters left to catch the train. The superintendent of the plant turned on the steam and found to his disappointment that the trap failed to work.

"He in turn called the engineer (now the examiner) and told him it failed to work. After close observation a blue tag was found on the trap that said "0-100 lb." The engineer claims to have fixed it so it would work on the steam pressure of 160 psi.

"Now can you tell me what he did? Could the body of the trap stand this overpressure? and where could he get an orifice to put in the trap so that it would work?

"We can't see how he did it, unless there is some little hint or catch that we failed to find." F. W. B.

Question No. 199

Should He Raise His Condenser Pressure?

WE ARE operating a 16-ton two cylinder single-acting water jacketed ammonia compressor at 140 lb. condenser pressure and 20 lb. suction pressure. Condenser water is entering at 45 deg. F. and leaving the condenser at 80 deg. F. We use considerable water and would like to know if it is more economical to use less water and raise the condenser pressure to 180 psi.? E. B.

Question No. 200

Preventing Sweat on Cold Water Lines

IN THE past I have seen used in several places what appears to be a granulated cork insulation on circulating and other cold water lines. However, I cannot remember the plants so as to make inquiries as to how it is applied. Can you tell me? G. N.

THIS TYPE of insulation now in fairly common use among utility companies was first noticed by the editor many years ago in the plants of The Cleveland Electric Illuminating Co. W. H. Aldrich, superintendent of power, describes the process of application as follows:

"After the first coat of paint is put on to the metal surface, as much cork as will stick is applied. The cork can be applied by hand or blown on with air. The hand method is more laborious but does not scatter so much cork. In either case, the cork which does not stick is collected on a canvas and used over. Three or more coats, depending on the job, are applied and finish coat of paint is then put on. Paint should be applied with a spray gun as brushing removes some of the cork.

"The cork used is Navy 8-12, sold by the Armstrong Cork Co. and we have used both 'Bitumastic' paint and 'Eusenheis' paint, both asphalt paints. A cover coat of aluminum paint finishes up the job. This is the only paint that I know of which will cover asphalt paints without danger of their coming through later."

Question No. 201

Vibration Tolerances

WILL YOU please tell me the vibration tolerances considered permissible for turbines and generators of various sizes? N. V. SVETAILO

THE TERM "permissible vibration" is a little difficult to define in that we generally find the machines are capable of withstanding much heavier vibration than we generally permit. Turbine generators, operating at 3600 r.p.m. are generally considered to be in good balance if their bearing pedestals have total amplitudes of vibration no greater than 0.001 in.

On the other hand, amplitudes of vibration as high as 0.003 in. on the pedestals can be withstood without harm to the machine. As compared with the above mentioned 3600 r.p.m. machines, the corresponding values for 1800 r.p.m. machines wou'd be approximately 0.002 and 0.006 in.

In this connection it should be understood that although the greater amplitudes of vibration can be permitted, they are not considered to be satisfactory and new machines just going into operation are generally found today to have vibrations less than 0.001 in. This limit applies to both 1800 and 3600 r.p.m. machines.

Westinghouse Elec. & Mfg. Co.
E. Pittsburgh, Pa. B. A. ROSE

Answer No. 161

The Safety Valve Creeps

ON P. 96 of the April issue N.E.A. complained of a safety valve which if set at 105 lb. soon creeps up to 110 lb. and has gone as high as 125 lb. The blowdown remains at 3 to 4 lb., however. He has replaced different parts and checked it carefully for dirt or a cocked spring. Nothing seemed to help.

The Spring Is Faulty

IN CONNECTION with the trouble N.E.A. is having with his "creeping safety valve," I suggest he has drawn a faulty spring. I base this suggestion on my own experience in a similar case. After all, there is only one force that prevents the valve's opening and that is the tension of the spring. That is, of course, if the valve is in proper condition. In my own case, a second new spring was installed after which the trouble disappeared.

Ft. Riley, Kan. CLOYD J. RAY

Answer No. 178

If the Brine Pump Stops?

ON P. 78 of the June issue J. K. admitted that he worked himself into a tight spot arguing about what would happen if the brine pump stopped and was not started again but the compressor was left running. Other answers were published on pp. 96 and 98 of the August issue.

T. F. Dries Up a Sticky Subject

STOPPING of the brine pump will allow the temperature of the room to rise and quite likely the ammonia gas

will be returned in a superheated state to the compressor. In effect the system is stopped up on the discharge side of the compressor and eventually all the refrigerant will find its way through the condenser to the receiver. Stopping of the brine pump will not freeze the brine unless the solution is weak because the brine has a lower freezing point than is likely to be reached. With the calcium chloride solution the freezing point is, of course, lower than for a sodium chloride solution.

The brine pump is used so as to maintain a steady temperature, and because it usually involves less refrigerant in the system than does direct expansion. In some systems the brine sprays over coils. Thus in the making of glue it is used this way to maintain the correct temperature of air circulating in the cooling boxes. The glue comes from the hot glue container, where it is kept agitated, and flows on belts.

These belts run through the chill boxes where the low temperature air carries away the heat. This cooling reduces the glue to a jelly like mass which adheres to the belt so it can be carried to the floor above and put on trays. From here it goes to the hot air storage rooms where it is brought back to a hard form again. Finally it goes to the grinders to be pulverized.

Philadelphia, Pa. T. F. CUNNINGHAM

Answer No. 187

Slag and Spalling Mean High Furnace Maintenance

ON P. 100 of the July issue H. G. K. said: "Costly furnace maintenance has been bothering us for some time due to high constant overloads (200 per cent) and low fusion ash coal which gives us a bed of hot syrupy stuff that causes undue spalling of our furnace walls. Replacing spalled brick in a wall 19 ft. long, 19 ft. high and 12 ft. wide is quite an expense, to say nothing of the enforced outage. We would like to install water cooled walls, but can't take the time out even though we could get the tubes and headers. Any tips on operation, air cooling or different type of brick which would help us would be appreciated." One answer to this question appeared on p. 99 of the September issue.

While Martin Hits the Walls

H.G.K. has a problem that has affected all plants at some time or another. Losses of boiler efficiency, due to the effects of excess air, leaks into the brick setting must be taken into consideration. In order to maintain a boiler properly the brick setting must always be properly taken care of.

There are several kinds used for boiler settings, namely, red brick and firebrick. Red brick is used in such portions of the settings that are well protected from the heat. Red brick should be so selected so tests made will show a sound, hard, well burned and uniform brick.

When selecting firebrick greater care must be taken, for the life of a boiler setting depends on the type of firebrick selected. However no boiler setting will last any length of time unless the brick is properly laid and bonded. Another great fault lies in the brick setting not being properly set to allow for expansion after the boiler has come up to its operating temperature level.

Several years ago firebrick was judged by its melting point, or at the temperature the brick would liquefy and run. However, experience, proves to us that this is only important within certain limits. Firebrick should also be judged by its plasticity under a given load. The tendency of firebrick to become plastic usually occurs at a temperature much below the melting point and to a degree that may cause the firebrick to deform under the stresses to which it is subjected.

Naturally plastic or softening temperature will be calculated upon the stresses the firebrick will be subjected to. Chipping a brick will show its quality; if the fracture is flinty, clean, and white in color, the brick is probably of good quality. If the texture of brick is fine and uniform its qualities are probably poor.

Spalling of firebrick is caused by high gases sweeping through the furnace at high velocities at the full furnace temperature. Spalling occurs rapidly if cold air is allowed to strike the heated brickwork.

A few years ago I had experienced a problem to patch up large cracks in a boiler setting. These cracks had developed through a wall 18 in. thick. Of course we overcame this difficulty, thanks to P.P.E. magazine's staff, and readers. Therefore having tried Plibrico and finding it good, I would suggest that H.G.K. use a monolithic lining of the furnace with Plibrico. The other suggestion would be to find out information about Carbofrax. In several plants that I have been stationed at we had Carbofrax brick and cement. With this brick (which is built up from the grates a short distance) less maintenance was experienced and brick setting repair was practically nil. As pointed out previously, too much stress cannot be laid upon the selection of proper refractories for boiler settings.

H.G.K. also states they cannot take time out for repair or change. Well, no refractory will stand up properly unless it is given a chance to set and dry out by keeping a low fire in the furnace. It may do for a while to rush a job, but in the end it will have to be done over again. Fortunately refractories of to-day can be used at full furnace temperature if brought up to full operating schedule slowly.

Constant overloads (200 per cent) is enough to tax most any boiler setting. H.G.K. will be lucky if any of the boiler setting will last after the peak loads are decreased (assuming the peak loads are due to higher production due to the war effort). While knowing nothing of H.G.K.'s position or classification, I would suggest he check his whole power plant and see if he can improve its efficiency. I would also suggest conducting an efficiency steam generating test. Sometimes there is a need of calibrating the flow meters, combustion control instruments and meters. Many plants to-day are running with instruments that need readjustment or repair.

No matter what repairs H.G.K. makes inside the firebox, it will take time and of course this means a shutdown of the plant, unless he has one or more boilers as spares so that the plant may operate while repairs are being made.

MARTIN N. GOZDENOVICH

Fairview, N. J.

Answer No. 189

Should the Heating System Be Drained?

THIS QUESTION was asked by J. Q. R. on p. 93 of the August issue. He referred specifically to the non-heating season when the pipes may be drained or left full of water. He also wanted to know why—regardless of what the answer was. One answer to this question appeared on p. 100 of the September issue.

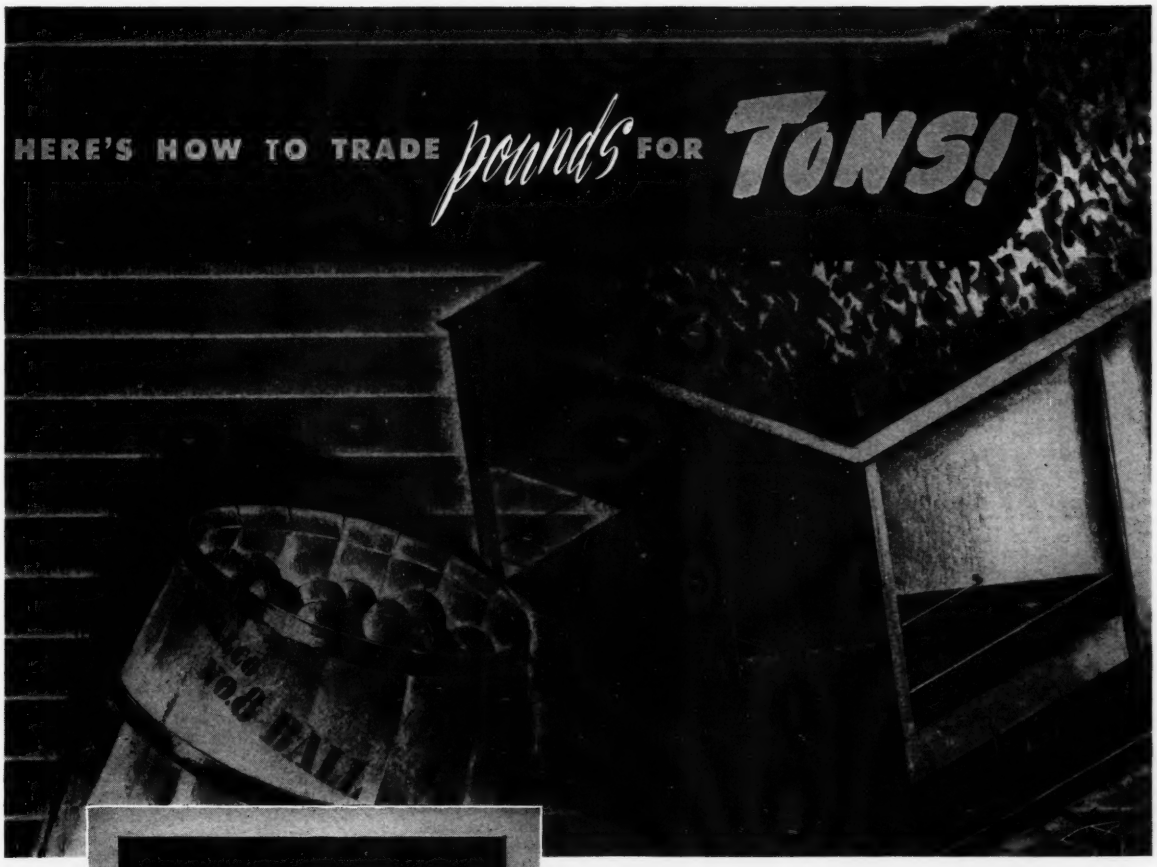
Check by Mr. C—Almost

HOT WATER heating systems should not be drained during the summer. I believe for good and sufficient reasons, and experience gained from operating such plants for many years. This is principally because of deterioration of the radiators themselves. I prefer to let the system remain full at all times up to the normal operating level in the expansion tank, for reasons as follows:

If you drain the system, then on refilling you will likely find much of the packing around the valve stems has dried out and is in leaky condition. Maybe some stress has also occurred on the piping somewhere and opened a leak. If the piping is kept full of water such things make themselves known at once and are not all discovered at one time when the service is needed.

The most important reason, however, is the effect on the radiators themselves. Radiator sections are connected together by wrought iron nipples, vulnerable because they are liable to rust out and become leaky. The cast iron radiator sections, however, do not rust appreciably in ordinary waters.

There are two kinds of nipples in general use: the slip nipple of comparatively thin metal and pressed into place; and, the right-and-left thread screw nipple which is heavier and not so vulnerable because of its greater thickness. There is little corrosion or rusting of these nipples if the system is left full of water.



In Nalco Laboratories, among the finest in the world, a staff of research chemists and engineers are continually developing newer and better methods of combating scale and corrosion.

Here, water treatment methods to meet the most difficult conditions are developed. No costly experimentation in your plant. No half-way measures — your scale problems will be under complete control. A continuous check report service insures this.

CONSERVE COAL THE *Nalco Way!*

AUTHORITATIVE sources have reported that 1/9 inch scale on boiler tubes can cause heat losses as high as 16%. That means a heavy waste of coal and loss of boiler capacity.

With the tremendous demands on American power plants, mining operations and railroad facilities, it is important that you investigate the possibility of trading *pounds* of Nalco feedwater treatment for *tons* of coal.

The Nalco System will keep your boiler tubes like new, eliminate heat losses due to scale, prevent carryover, foaming and priming and give you controlled blowdown.

Take the steps now to conserve time, money, manpower and materials. Write for a Nalco Survey of your plant.

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This water has been boiled out so there is little oxygen in it, whereas if the air is allowed to enter the inside of the radiator during the summer season rusting is likely to go on continually. I can mention many systems, especially steam heating systems, where they have had expensive trouble on account of radiator nipples giving out.

One such case is a hotel where every radiator had to be taken down and re-nippled. I have in mind, and under observation at present, a job in a church where they have had to take down several radiators to replace leaky slip nipples. In this installation new leaks are constantly springing up. The moral of this is: In planning your hot water heating system insist on the use of screw nipple radiation even if it does cost a few cents more. Also insist on the system being kept full of water at all times so that the oxygen of the air will not get into the radiators.

There is, however, one other point to be observed. Water is sometimes found slightly acid or corrosive in nature. This is often shown by the fact that the water standing in the water glass of a boiler shows a red or rusty tint. The way to get rid of this is to dissolve a little soda into your boiler to render the water alkaline instead of acid.

Logansport, Ind. C. C. CUSTER

Letters and Comments

Four A. W. Kramer's Straighten Out a Family Affair

FROM a letter received recently: "Will you please send me the two volumes which you published some years ago entitled 'Electricity—What It Is and How It Acts' by A. W. Kramer?" Signed, A. W. Kramer, Corpus Christi, Texas.

The reply: "Unfortunately, we cannot send you the complete work as we are entirely out of Vol. II. We still have a number of copies of Vol. I, however, in case you would like to have the single volume." Signed, A. W. Kramer, Chicago, Ill.

By return mail: "Received your letter advising me of the shortage of Vol. II and am just about flabbergasted. I thought this book was written by A. W. Kramer, my father, who is also an electrical engineer, and that I had overlooked it. Then I find that there are three A. W. Kramers. Electrons certainly must run in the Kramer family. I am also a radio engineer so you can obtain the Yearbook of Broadcast Advertising and show the boys around Chicago that you were chief engineer at KRBA at Lufkin, Texas, last year. Send the book by all means, and if I get accused of being the author, it will be a pleasure. Is it possible that we are remotely related? My family is from Alexandria, La., and my grandfather John Kramer who settled here in the early seventies from Germany." Signed, A. W. Kramer, Corpus Christi.

The final letter: "The book has been mailed and you should have it shortly. The coincidence is heightened by your also being a radio engineer. I am not a radio engineer professionally but have been a member of the I.R.E. and the A.R.R.L. for many years and have been a Ham since the first World War. W9CVP has been off the air now since December 7, but before that it was on the air continuously for a period of over 20 yr. on both phone and CW. The A.W.K.'s all seem to be E.E.'s. There is still a fourth one whom you will find listed in the A.I.E.E. Yearbook as Design Engineer for the General Electric Co. at Bloomfield, N. J. I do not think that we can find any closer relationship. My father came to this country from Holland in the eighties and I am quite certain that there were no German connections." Signed, A. W. Kramer, Chicago, Ill.

With at least four of the A.W.K.'s pedigreed and identified we can proceed with the business of making Anxious Willing Kilowatts—also professionally related to the other A.W.K.'s.

Forced Draft Requirements —Get Joe Steamed Up

THE ARTICLE by J. R. Darnell, titled Forced Draft Requirements—Get Joe Steamed Up (p. 86, August issue) also aroused my interest and ambition. Reading Mr. Darnell's article caused me to refer back to the original by Mr. Sims. I fully agree with Mr. Darnell's reflections, and the key to the entire situation is well stated by his statement that Mr. Sims' chart does not take into consideration the exit gas temperature. However, I am unable to agree with some of Mr. Darnell's calculations, so I stick my neck out as follows.

The ultimate analysis seems to be as follows with the notation of the presence of 3.1 per cent moisture.

C	0.843
H	0.047
O	0.052
S	0.007
ash	0.051
	1.000

The analysis of the coal as fired would then be as follows:

C	0.8430
H	0.0436
O	0.0244
S	0.0070
ash	0.0510
H_2O	0.0310
	1.0000

Taking the assumption of 10 per cent carbon in the refuse and using the latter analysis, the weight of the refuse would be 0.051 divided by 0.9 or 0.0567 lb. and the unburned carbon, 10 per cent of this amount or 0.00567 lb. This checks the rather cumbersome method outlined by Mr. Darnell, and is considerably shorter.

I am unable to check the form of equation 2, as well as the result from the figures substituted in the one just below the same equation. In equation 2 the term 0.375S should be in the numerator of the fraction, instead of the denominator (according to my derivation), also the 0.375 to be 0.296 so that the equation would read

$$\text{Max. } CO_2 = \frac{20.9}{1 + \dfrac{2.38\,(H - O/8) + 0.296\,S}{C}}$$

Since the sulphur content is generally small, it will not affect the result as calculated on a slide rule if it was neglected completely. This equation could be expressed in terms of the theoretical air since this has already been determined. The form would be

$$\text{Max. } CO_2 = \frac{1}{1 + \dfrac{0.33TA}{C}}$$

Where TA = theoretical air, lb./lb. coal
C = carbon content of coal in lb./lb. coal.

The author's statement that the unburned carbon will reduce the theoretical amount of air required per pound of coal is incorrect. The theoretical air for this coal is 11.16 lb. regardless of how it is burned, since the theoretical air is that required to burn the coal completely without any oxygen remaining.

The result of the equation where the author assumes 15 per cent CO_2 seems to be incorrect. Thus he gives

$$\text{excess air} = \frac{(18.7 - 15)\ 0.791}{15.0\ (100 - 18.7)} = \frac{2.93}{12.2} \text{ or 24 per cent}$$

The 2.93 is correct, but the numerator, using the above figures is 1220.0 instead of 12.2.

AVOID this Costly Valve Leakage

AREA OF LEAK	AIR		STEAM		WATER	
Diameter Inches	Number of cubic feet per month at 75 lb. pressure	Total cost of waste per month 11c per 1000 cubic feet	Pounds wasted per month at 160 lb. pressure	Total cost of waste per month 65c per 1000 lb.	Gallons wasted per month at 60 lb. pressure	Total cost of waste per month 16c per 1000 gallons
1/2"	13,468,000	$1,481.44	1,219,280	$792.53	1,524,100	$243.86
3/8"	7,558,500	831.44	684,290	444.79	855,360	136.86
1/4"	3,366,990	370.37	304,820	198.13	381,020	60.96
1/8"	824,570	90.70	74,650	48.52	93,310	14.93
1/16"	213,000	23.43	19,280	12.53	24,110	3.80
1/32"	52,910	5.82	4,790	3.11	5,990	.96

Enlarged copies of this chart printed on cardboard are available on request; also ask for Lunkenheimer Catalog 78.

Valves aren't so easy to replace these days . . . practically all materials going into their manufacture are on the critical list. This means that it is up to every valve user to take the best care of what he has to insure the longest possible service life.

Leaky valves are saboteurs of your production schedules . . . obstructing your best efforts and increasing your costs. The chart illustrated above gives you an idea of what valve leakage costs you.

Fortunately, valves respond to good treatment. Careful handling, immediate repair of the slightest leaks, and prompt replacements of worn parts will keep them on the job, ready to meet the demands imposed by industry's unprecedented war effort.

Since virtually all materials used in the manufacture of valves are on the list of critical materials, valve users are urged to furnish the highest possible preference ratings and proper "end use" symbols on their orders. This will be of mutual helpfulness.

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LUNKENHEIMER VALVES

There seems to be a misprint in the equation used to calculate the moisture and hydrogen loss in that the multiplication sign should be a plus sign. Then too the figures are for atmospheric pressure, whereas the flue gas is actually exerting only a pressure of from 1 to 2 psi, abs. This however will not affect the result to any appreciable extent.

The ash pit loss calculation is in error. Using the figures the author has, the result should be 444 B.t.u.; however, the loss appears to be the weight of unburned carbon multiplied by 14,600, which would be 0.00567 by 14,600 equals 83 B.t.u.

Now, since the radiation loss must be assumed, why would it not be easier to calculate the amount of air required from the assumed efficiency, and gas temperature; and from this find the CO_2, and resulting flue gas analysis if it is required.

Using the analysis of the coal as fired and heating value of 14,688 B.t.u. per lb. on the same basis:

Heat absorbed by the water
$0.85 \times 14{,}688 =$ 12,460

Assuming 2.5 per cent lost by radiation
$0.025 \times 14{,}688 =$ 367

Moisture and hydrogen loss
$9H\,(1089.1 + 0.46t_g - t) =$
$9 \times 0.047\,(1089.1 + 0.46 \times 450 - 70) =$
$0.423\,(1089.1 + 207 - 70) =$ 518

Ash pit loss
$0.00567 \times 14{,}600 =$ 83

Dry gas loss
$W_{dg} \times 0.25\,(t_g - 70) =$ ——

——
14,688

Thus the dry gas loss would be 14,688 — 12,460 — 367 — 518 — 83 = 1260 B.t.u. /lb. coal. Using the assumed flue gas temperature (which in any case could be determined from the temperature of the last fluid that the gas is heating), the weight of dry gas can be determined, and from this the weight of air supplied per pound of fuel.

$1260 = W_{dg} \times 0.25\,(450 - 70)$
$W_{dg} = 13.26$ lb./lb. coal

Since
air + 1 lb. coal = refuse + dry gas + H_2O

then
air + 1.0 = 0.0567 + 13.26 + 0.423
air = 12.74 lb./lb. coal
per cent excess air =

$$\frac{(12.74 - 11.16)\,100}{11.16} = 14.2$$

This small amount of excess air would probably cause difficulty in the furnace design and it would be necessary to either lower the flue gas temperature (which might be impossible) or else operate under a lower efficiency.

The resulting flue gas analysis would be determined as follows:

Weight $CO_2 = (0.843 - 0.00567)\,3.67 = 3.07$ lb.

Weight $N_2 = 11.16 \times 0.768 \times 1.142 = 9.80$ lb.

Weight $O_2 = 11.16 \times 0.232 \times 0.142 + 0.00567 \times 2.67$
$= 0.3676 + 0.0151$
$= 0.3827$ lb.

	Mols.	Vol. %
$CO_2 = 3.07 \div 44 =$	0.0698 =	16.15
$N_2 = 9.80 \div 28 =$	0.3500 =	81.15
$O_2 = 0.38 \div 32 =$	0.0119 =	2.70
	0.4317	100.00

C. M. Leonard
Assoc. Professor
Mech. Eng.
Oklahoma A. & M. College
Stillwater, Okla.

Joe Gets Steamed Up Again

The original article by Mr. Sims under the title "How to Determine Forced Draft Air Requirements" in the February issue (p. 94) which has invoked several discussions, was directed to the problem of determining air requirements for forced draft and I thought that my comments in the August issue (p. 86) were apropos to that particular topic. However, if we were to attempt to follow all the ramifications of Mr. Leonard's remarks, I'm afraid we would get far afield. Mr. Leonard agrees with me that Mr. Sims' chart does not take into consideration a very fundamental element, namely, exit gas temperature. This is the crux of the whole problem, but after having made that observation Mr. Leonard appears to drop the matter, and, for the most part, indulges in "quibbling."

Even assuming that there might be some minor errors in my calculations in arriving at a heat balance, my original contentions are still sound and have not been shown to be wrong. In addition to disregarding the exit gas temperature, Mr. Sims gave an illustration for his chart by assuming 60 per cent excess air with 85 per cent efficiency. Regardless of possible minor errors in some of the items in my heat balance, it was tabulated merely to show that the above conditions postulated by Mr. Sims are impossible. Mr. Leonard does not discuss this matter at all and apparently agrees with my conclusions.

Equation 2 in my article for calculating the maximum theoretical CO_2 was taken from an article in Power, Volume 48, December 31, 1918, entitled "What Percentage of CO_2 Can Be Obtained." That equation did not account for the sulphur, so I used the constant of 0.375 shown in a similar equation in a paper presented by Andrew A. Bato before the American Society of Mechanical Engineers in New York, February 24, 1926. This paper was printed in full in the April, 1926 issue of Mechanical Engineering, pp. 330-36, and in abstract in Power Plant Engineering August 1, 1926, p. 839.

Mr. Bato shows how he arrives at his equation, which is:

$$\text{Max. } CO_2 = \frac{8.86}{0.422 + \frac{H - 0/8}{C + 0.375\,S}}$$

The values in this equation may be converted to the simpler equation which I used by dividing the numerator and denominator by 0.422. By this procedure, if we wanted to split hairs as Mr. Leonard does, we might say the equation given in Power is wrong because the constant for hydrogen should be 2.37 instead of 2.38, since $\frac{1.0}{0.422} = 2.37$

Mr. Leonard does not explain why he thinks the sulphur constant should be 0.296 instead of 0.375, as used in my equation. Perhaps he will at least agree that the equation for the weight of air required per pound of fuel, as expressed by the following, is correct:

Lb. air per lb. fuel
$= 11.52C + 34.56\,(H - 0/8) + 4.32\,S$

If we can agree on that, we see that the ratio of the weight of air for sulphur as compared to carbon is $\frac{4.32}{11.52} = 0.375$

This means that for each pound of air required to burn carbon, only 0.375 lb. is needed for the sulphur.

As another concrete example of Mr. Leonard's quibbling, one needs only to refer to his criticism of my equation for excess air which was given exactly as presented by Mr. Bato. The latter's equation was given as follows:

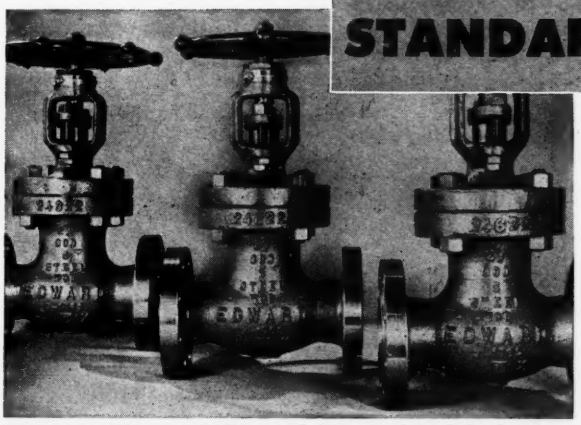
$$E = \frac{CO_2\,[(\text{max.}) - k]\,79}{k\,(100 - CO_2\ \text{max.})}$$

Now any practical engineer other than a college professor would know that in substituting values in this equation the value of 79 should be 0.79, and 100 represents 100 per cent. Therefore, when we have a maximum theoretical CO_2 value of 18.7 per cent, a CO_2 reading of 15 per cent represents 24 per cent excess air. According to Mr. Leonard's literal interpretation of the equation, the excess air value would be only about 0.2 per cent.

Also with reference to the moisture and hydrogen loss he attempts to carry the calculation to an absurdity by stating that the absolute pressure of the flue gas should be considered. Boiler tests as a practical matter do not and cannot involve the same details of accuracy as one would observe in checking the atomic weight of an element in the laboratory. It's a wonder that Mr. Leonard doesn't insist on making allowance for slight air compression in calculating fan performance, as one should do if he wishes to carry his calculation to absolute exactness.

Finally, I wish to take issue with Mr. Leonard on his statement that in my example the theoretical amount of air required per pound of coal remains the same regardless of how it is burned. So far as an original pound of coal as fired is concerned, he is correct. I should have stated that the amount of unburned carbon reduces the theoretical air per pound of coal burned. He does tacitly agree that my figure of 11.15 lb. for the weight of air is correct by giving a figure of 11.16 lb. Can anyone read the difference on a slide rule with any degree of certainty? Certainly any practical en-

Cut Delivery Time with These STANDARD EDWARD VALVES



It pays to use Edward 300 lb sp steel globe, angle and check valves. Note strong, functional design of 2½ in. cast steel globe stop valves above. Fully guided disk permits installation in any position.

Choosing these standard Edward valves means quicker delivery. But important as that is today, there are other big dividends—such things as maximum job and part interchangeability, easier installation and other time saving factors.

Built with the customary Edward emphasis on "plus value" construction, these versatile forged and cast steel valves fit a wide variety of power, petroleum, process piping and industrial services. For more detailed descriptions and dimensions see Edward Catalog No. 101. If you haven't a copy, a post card will bring you one by return mail.

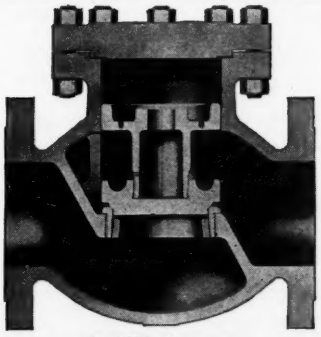


Fig. 6597—Horizontal

CAST STEEL CHECKS . .

For 300 lb check valve service, choose Edward Fig. 6597 (horizontal) or Fig. 6598 (angle). Cast steel, piston type, flanged ends, sizes 2½ in. to 12 in. Integrally cast ribs guide disk-piston assembly throughout travel. Streamlined bodies contoured for free flow. Also built for pressures to 1500 lb and in sizes to 12 in. Forged steel check valves, ¼ in. to 2 in. available.

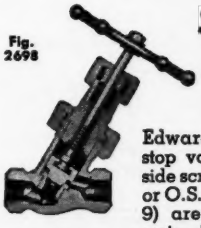


Fig. 2698

SCREWED STOP VALVES

Edward screwed end stop valves, either inside screw (Fig. 2698-9) or O.S. & Y. (Fig. 2688-9) are going into all sorts of service today. Full area forged steel bodies minimize pressure drop. EValloy seats and disks. Drop tight closure. Globe and angle, for 600 lb sp in sizes ¼ in. to 2 in.

FLANGED STOP VALVES . .

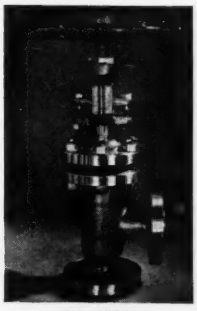
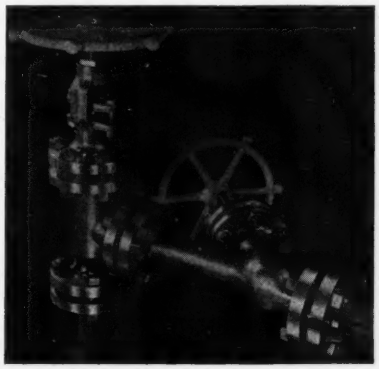


Fig. 4829

There's long, economical life in Edward globe and angle forged steel flanged end stop valves. Seats, disks and stems are EValloy, Edward's specially processed stainless steel. Unique swivel plug type disk design prevents galling. Heat treated forged steel bodies proportioned to reduce distortion under heat. O.S. & Y. with bolted bonnets and bolted glands. For pressures to 600 lb sp, sizes ½ in. to 2 in. Same design characteristics available in valves for service to 1500 lb.



INTEX GLOBE STOP VALVES . .

Fig. 3264

GET THIS FOLDER!

Intex valves are fully described in Catalog 12-GS. Write for a copy today!

Disks and integral seats of these Edward Intex valves are hard surfaced with Stellite. Disassembly unusually easy, working parts readily accessible. Socket welding, flanged or screwed ends for pressures to 1500 lb at 950 F.

BLOW-OFF VALVES . . . .

Edward blow-off valves are designed to avoid damaging shock to piping. Simple, frill-free construction with no unnecessary parts to erode or cause clogging. EValloy and Stellite seats and disks. Globe type seating for tight closure. Straightway and angle for 150 to 1500 lb sp service.

THE EDWARD VALVE & MFG. CO., INC.
220 West 144th Street, East Chicago, Ind.

EDWARD *Steel* VALVES
CAST AND FORGED

gineer will agree that carbon that is not burned will not use up air, and that the lesser the amount of carbon which does remain in the coal which is actually burned, the lesser the air required either with no excess or with any given percentage of excess.

Taken as a whole, Mr. Leonard's discussion sheds little or no light on the problem as presented by Mr. Sims.

Naperville, Ill. J. R. DARNELL

What the Operator Wants to Know

ALFRED IDDLES' reference to copper deposits, in his excellent article "What the Operator Wants to Know" September issue, is very interesting. In fact, it caused a painful collision between my two brain cells, the result of which is an IDEA. It may seem that small bore, high velocity rifles may have little in common with high pressure boilers, but—here goes my neck out.

A few years since, we small bore experimenters worked out some excellent loads, using copper jacketed bullets, the latest powders, and non-corrosive primers. Due to the use of the latter type of primer, we assumed that cleaning of the bore was unnecessary. After some expensive barrels were found pitted (are my ears red) investigation proved that the pits were caused by electrical action set up between a light copper wash deposited by the copper jacketed bullets, and the bore itself.

With respect to pressure, heat, and chemical activity, conditions in a rifle barrel are not unlike those obtaining in a high pressure boiler. So, is it possible that heavy deposits of copper, on or in a pit in a tube, promote the growth of the pit by electrolytic, or shall we say, galvanic action?

Of course, I offer no comment as to the source of the copper.

After reading the above, the whole thing seems unlikely, but I am one who still believes, "That big oaks from little acorns grow". Also Fairies, Little People, etc.

Editor's Note: If the R.A.F. boys were boiler operators I am sure they would know what caused the copper trouble. Indeed it would be quite simple for them. They would lay it to the Gremlins.

Spending Money Like Water

IN SOME correspondence that we had a few months ago, you asked for suggestions, particularly in connection with the problem contest. It strikes me that the prize awards are too often based upon spending an excessive amount of money. I remember one refrigeration problem in particular, published about a year ago, and remarking at the time "money for changes was spent like water."

Regulator, thermo-controls, relays and what have you were put on. It was beautiful. I am sure it was just exactly the way I would want the set-up done. But, and that's a great big but,—where are you going to get a boss that will approve a repair bill of that size no matter what head you put it under?

My boss, and I venture to say 90 per cent of that classification, wants to know the cost first, what he will get in return, and cares very little about how easy it is to operate as long as it can be made to work for as low a cost as possible.

He's not a tough guy to work with, in fact the best man I ever worked for, but he's practical and he knows his business. He doesn't say, "Don't spend money," but he wants to know everything he can get when he does.

As an engineer I think he's right. That's what he has me here for. To go out and spend his money for fancy gadgets? Yes, they are fancy when you can operate just as successfully and save money without them. I think that the most practical solution of any problem is the one which is most practical from the engineer's viewpoint and the easiest on the boss' pocketbook.

Don't you see it my way? I answered your refrigeration question and all I did was change pressures by cutting down on the incoming water. That was a saving and I got third prize. I was nearly floored and still have the money under the glass on my desk. The man who won first prize went out and spent $500 of the boss' money, only to do just what I did except to make it automatic while mine was manual.

What does the boss care about the difference between automatic and manual control? He does, however, care a great deal about the $500 and it's my claim that that is what makes the engineer's job important, both to the man with the license and to the boss, who after all is the guy that keeps us working.

Buffalo, N. Y. HAROLD E. GETHOEFER

Avoidable Waste

RECENTLY I found a large ad in the evening paper stating that a well known firm was greatly in need of engineer draftsmen, but stated that no one except fast workers would be considered. I wrote them and said that in my estimation that ad was the most stupid, silly thing I had ever seen in print, and offered the suggestion that all they needed was a few good squad leaders with a teaspoonful of brains to plan and direct the work for the men they already had.

I have learned from long years of experience that a man is never so happy as when he is working up to his full capacity, and a good boss knows how to develop his men and get the most out of them. We should not forget that to do good work and to receive recognition for it satisfies the soul as completely as any human experience. Happy workmen are well employed workmen.

I was in business for myself a number of years, but war conditions compelled me, like many others, to drift back again to my old line of work. It is needless to say I am astonished by the incapability of many of the squad leaders, the majority of whom are not getting half of what could be gotten out of their subordinates because they do not understand human nature; they cannot teach and stimulate, but only frighten and irritate. An ineffective, indifferent boss has the mistaken idea his men aren't entitled to any consideration. The successful boss and leader, however, knows that a person who is intelligently directed and encouraged is worth several who have had all sense of cooperation crushed out of them.

Most of us dislike avoidable waste. Here is a squandering, unnecessary expenditure that transcends all others which cannot be checked until those at the head of our big business scrutinize the little bosses more closely and choose only those who know the economics of bossing.

This is written for the benefit of the "dribblepusses" who have only been on the job a short time, the old experienced bosses already know all about it.

It is also noticeable that some executives make a greater effort to keep a good secretary than a good wife. Little can be expected from men with an example of that kind before them. I happened to be connected with an outfit of this kind a while back.

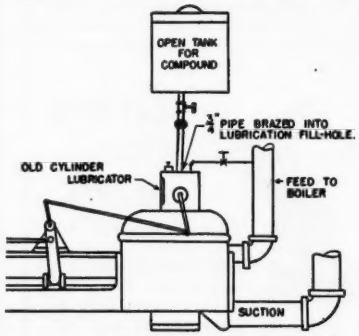
Let us all keep our feet on the ground, our heads cool and remember the bit of verse:

Let this be your goal, be fair to all
Pay for what you get or do without
Ask no favor, great or small
You then can meet them all when you go about
And this I would recommend:
Be faithful, grateful, but never bound.

Johnstown, Pa. H. S. BRACKEN

Feeding Boiler Compound

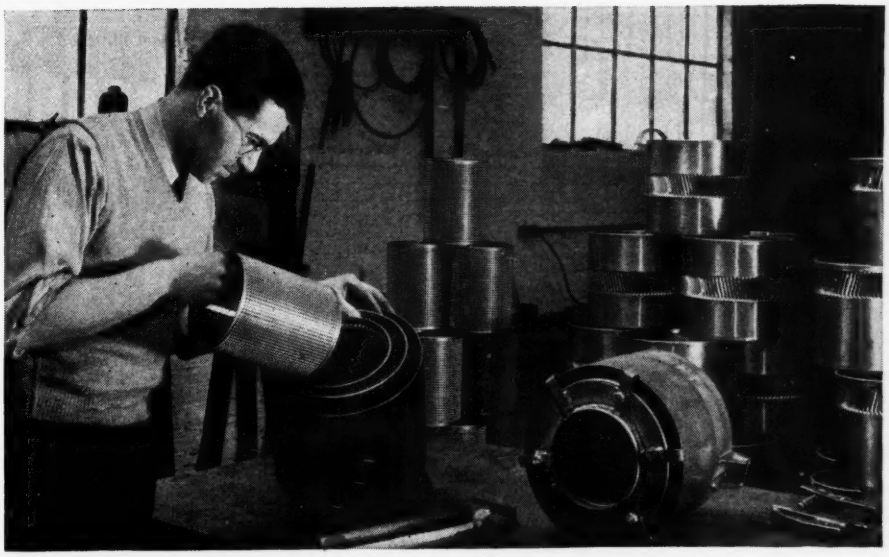
GEORGE KIRK'S article on a Simple Compound Feeder (June p. 74) recalls one of my first brainstorms, Malarkey's Unpatented Apportioning Boiler Compound Feeder, and I am attaching a sketch which may or may not be worth publishing as it was shown in Power about 10 or 15 yr. ago. The installation



Hookup of cylinder lubricator for feeding boiler compound in proportion to the feedwater flow

I originally had would feed about 3 to 4 gal. of compound in 24 hr. Maximum feed would depend upon size of lubricator available and probably what the compound was composed of. (Confidentially, I think Manzel stole my orphan idea as they advertise one that looks just like it.)

Melrose, Mass. O. W. MALARKEY



Inserting a 16 gauge perforated Monel cylinder to complete a separator. Sixty of these units using 180 Monel cylinders are now in service in British supply cargo vessels built under supervision of the U. S. Maritime Commission.

How improved Material and Design for Boiler Accessory

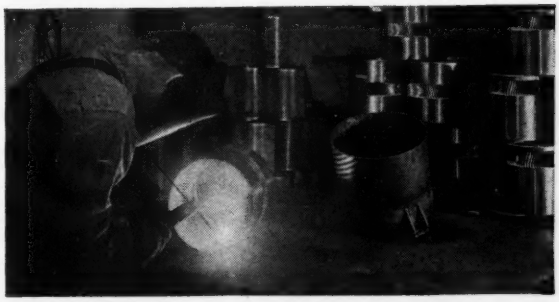
REDUCED COST 30%, WEIGHT 50%

Change from cast bronze to welded Monel sheet also increases life of Steam Separator

The Dri-Steam Boiler Separator is a compact unit mounted inside of the boiler drum. Removing moisture and solids from outgoing steam, it assures dry, clean steam at boiler outlet under all operating conditions.

Some time ago the makers, Dri-Steam Products, Inc. of New York re-designed this unit with excellent results. Cost of the separator was cut one-third. Weight was reduced by one-half. In over two years of actual service not a single failure has been reported.

The change consisted of re-designing the separator to take separating elements made of Monel sheet instead of cast bronze. The bronze had a limited life, frequently as short as three months.



Electric welding a 14 gauge Monel cylinder for the Dri-Steam Boiler Drum Separator.

Other materials were tried, but proved too difficult to work. Monel was finally adopted because it was found amenable to perforating, punching, and spot and electric welding . . . and its combined strength and resistance to corrosion assure freedom from trouble, and eliminate need for maintenance.

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Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

How Would You Do It?

Problem 24. No letters, no priorities, no awards, almost no judges. The sad, sad story of a negatively involved project

WHEN THE MEMBERS of our Board of Judges were protestingly dragged back to their nicely padded chambers after their somewhat futile but admirable attempt to enlist in the air forces*, their first act was to dig into the mail bag to sort out the answers to the big Priority double prize contest, announced in the September issue. And, Lo, what do you suppose they found? No letters; no mail; just nothing.

They Were Puzz'ed

Somewhat puzzled they looked at one another, looked in the bag again and after some discussion came to the conclusion that they were too early. Apparently, the answers to the problem had not begun to arrive. Relapsing into their normal comatose state they did not give the matter another thought for 7 days. It is improbable that they would have thought of it then had not two of the old fellows become involved in an argument over what day of the week it was. The chief justice said it was Thursday, and one of the associates said it was Monday. Fortunately, they were separated before serious damage was due to their respective whiskers; but in settling the argument, someone called attention to the fact that it was the tenth of October, and that the closing date of the prize contest was long past. All letters were to have been in by October 1st.

Nothing in the Bag

They looked in the bag again. But no letters; no answers to the contest.

It took the judges some time to assimilate the sad fact, but in the end they realized the gravity of the situation. Here they were, gathered together for the sole and solemn purpose of judging the answers to the contest, and there were no answers.

Careful search and double checking only served to emphasize the bitter truth. Not a single reader had seen fit to try for a $25 War Bond—and there were two of them waiting!

Were the judges' faces red!

The Captain Was in Swimming

Well, there was nothing to do about the matter. They called Captain Morris down in Miami Beach, who propounded the problems, but the General who answered the phone said Captain Morris was in swimming and could not be reached; furthermore, he was in the army now and had problems of his own.

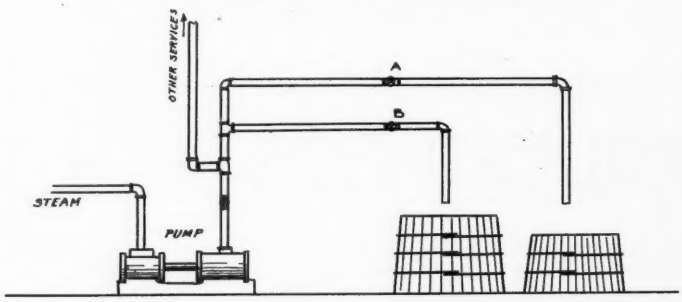
Evidently the priority problems were too involved and entailed too much effort and originality to interest anybody at this time. The problems resulting from priority regulations are tough enough to cope with in our routine work these days without spending extra time writing about them. We were probably at fault in presenting this kind of a problem, but at the time it seemed logical that this sort of thing would be of interest. We were very wrong.

Fortunately, about the time we were so depressed about this thing, our Hero happened to drop in the office with one of his customary headaches. For once, we were glad to see him and his problem, this time, does not seem very difficult. There are several solutions, but the case offers opportunity for the display of plenty of ingenuity and we are anxious to know what you fellows who read this page will do with it. Don't let us down this time.

*See Page 93.

Problem 25

THE CASE OF THE TWO VATS



Our Hero has not bothered us very much lately with his worries, but shortly after Captain Morris left to put some organization into the Army Air Forces, he (our Hero) dropped in with this little headache. As we reached for the aspirin he sketched the diagram shown above and explained the situation.

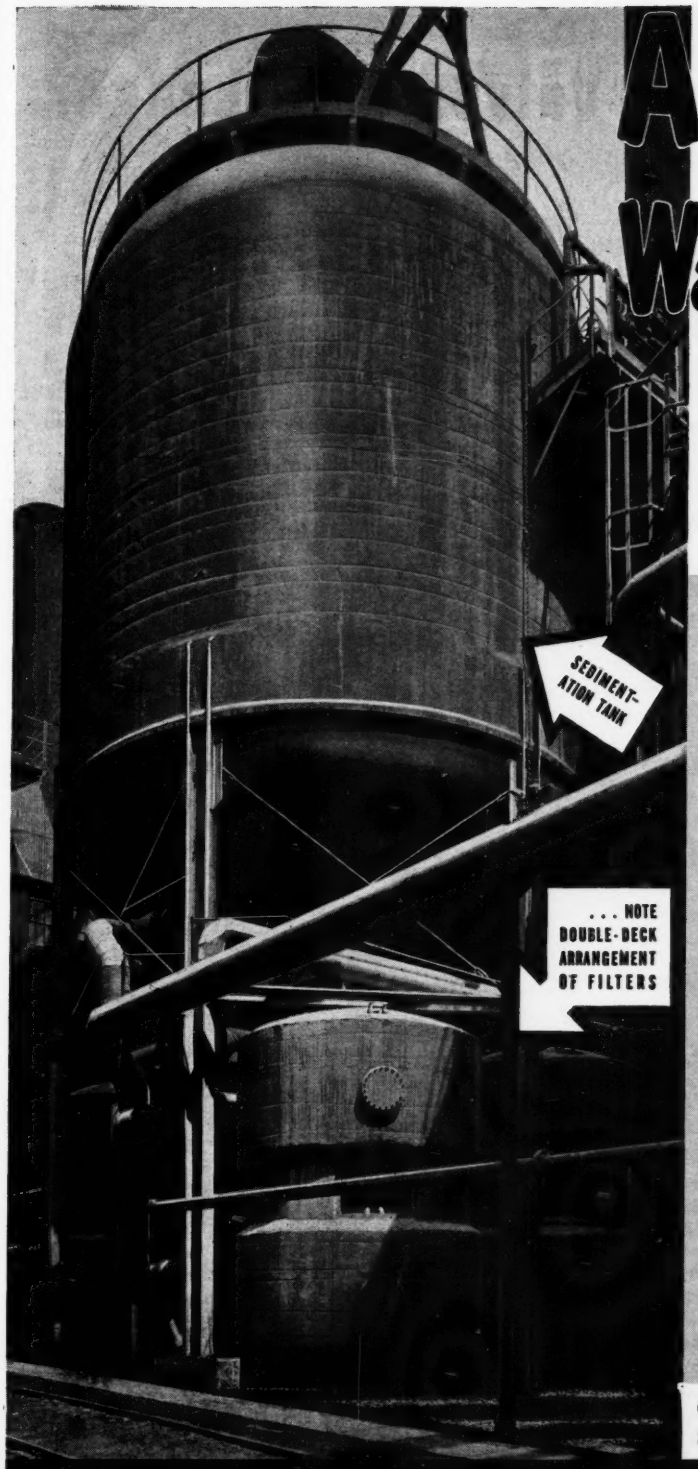
It seems that among many other things, our Hero has charge of this arrangement for pumping hot water into a couple of chemical mixing vats. We asked him what they were for, but he only gave the customary reply that is heard so much these days when you ask somebody a question they can't answer, to wit, "It's a military secret."

One of these vats has twice the capacity of the other and requires twice the flow of water to fill it in the same time as the smaller vat. It is a requirement of the process that both of these vats be filled simultaneously, but don't ask us why. Heretofore, our Hero explained, this has been accomplished manually by means of the valves A and B.

The pump also supplies other services and the pressure on the water line varies between considerable limits. There is no pump governor on the steam line at the present time, but one could easily be put in.

This system, however, has not proved very satisfactory. If a blond from the front office walks through the plant while the operator has the valves open, often he forgets to close them and there is a flood to take care of. So, our Hero wants to devise a system whereby the flow to the two vats can be proportioned automatically, in fact, if the whole operation of starting and stopping the flow and filling the vats could be done automatically, so much the better.

How would you do this if you were in our Hero's shoes? Write your opinion of this case in a letter of not over 1000 words and send it to the Contest Editor by November 30. A first prize of $15 will be awarded for the best letter; a second prize of $10 and a third prize of $5 for the two next best letters. Entries in this contest should be marked Problem 25 and addressed, Contest Editor, Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill.



A BIG JOB of Water Softening

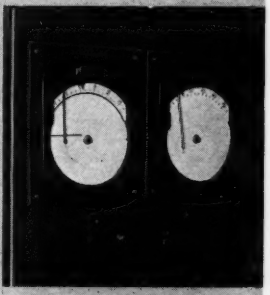
100,000 GALLONS PER HOUR COCHRANE DEAERATING HOT PROCESS SOFTENER AT PITTSBURGH PLATE GLASS COMPANY

AT THE BARBERTON, Ohio, plant of the Pittsburgh Plate Glass Company, is installed the largest deaerating hot process softener in the world—a Cochrane unit, of 100,000 gallons per hour capacity.

Heating and deaeration of raw and treated water are accomplished by external jet heaters and atomizers, while the condensate (18,000 GPH) is deaerated with a separate tray-type deaerator.

Lime and soda ash are used as reagents and are mixed in separate tanks, double-decked to conserve space. Reagents are proportioned to the sedimentation tank by means of proportioners electrically controlled by Cochrane Flow Meters.

Like the chemical mixing tanks, the eight 11 ft. vertical filters are also double-decked as shown. Interesting facts about modern water softening are contained in Cochrane Publication No. 3000. Write for a copy.



Cochrane Electric Flow Meters control proportioning of chemicals to sedimentation tank

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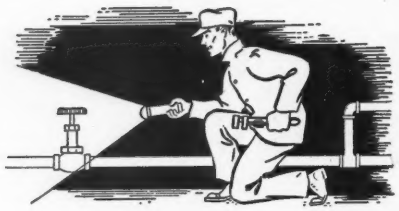
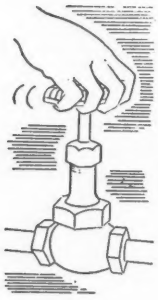
Making Your Globe Valves Last Longer



A bit of timely advice on how, when, and what to do to make your globe valves render the longest possible service

By M. S. PALMER, Manager
Hancock Valve Division
Manning, Maxwell and Moore, Inc.



INASMUCH as new equipment has become difficult to obtain, the use of your present equipment can be prolonged by doing the proper thing at the proper time. Following are some timely hints to the proper operation, installation and maintenance of globe valves in making them last longer.

Proper Operation

The intermittent use of steam valves means that such valves are often closed while they are still hot. As the parts cool, contraction of the stem and disc causes the disc to lift slightly off its seat, allowing a small amount of steam to leak through. This leakage tends to cut the seat ring surfaces, causing a permanent and increasing leakage.

The remedy is to have the operator give the valve handwheel another twist after the valve has cooled, thus taking up the contraction of the internal parts.

Installation

When installing screwed end valves, do not use too much force in making up the joint. You may distort the body and seat, thus causing a leak.

When installing new valves, be sure pipe lines, tanks, etc., are clean inside—free from dirt, scale, chips, turnings, and other foreign matter which could damage seating surfaces. Be sure insides of valves are clean, too.

Valves found leaking through the seat and disc, or through the stuffing box, should be repaired or repacked as promptly as possible. The longer leaks are allowed to continue, the more wear, and destruction of vital parts occurs.

Operators should not use long wrenches or bars to operate valves. The additional leverage may twist the stem or cause other distortion.

Before installing valves, make sure that they are being installed correctly. Some valves can be installed in only one position, such as liftcheck valves and stop check valves.

Correct Maintenance

A valve may be damaged extensively if it is improperly assembled or disassembled. The disc and stem should be checked to make sure they are in the open position before a valve is disassembled.

The seat in a valve body is one of the most important parts in the valve. When removing the seat, make sure the proper wrench is used so that the seat is not distorted.

After a valve has been in service a very short time, an additional ring of packing should be inserted. A new ring of packing will take up the shrinkage of the packing due to the heat when it is first applied.

When steel valves are installed on high temperature steam service over 750 deg. F., difficulties with leaks at the bonnet joint sometimes occur due to creep at the high temperature. A practice which has eliminated this difficulty in many high temperature steam installations is to retighten bonnet bolting after the first 200 hr. of operation.

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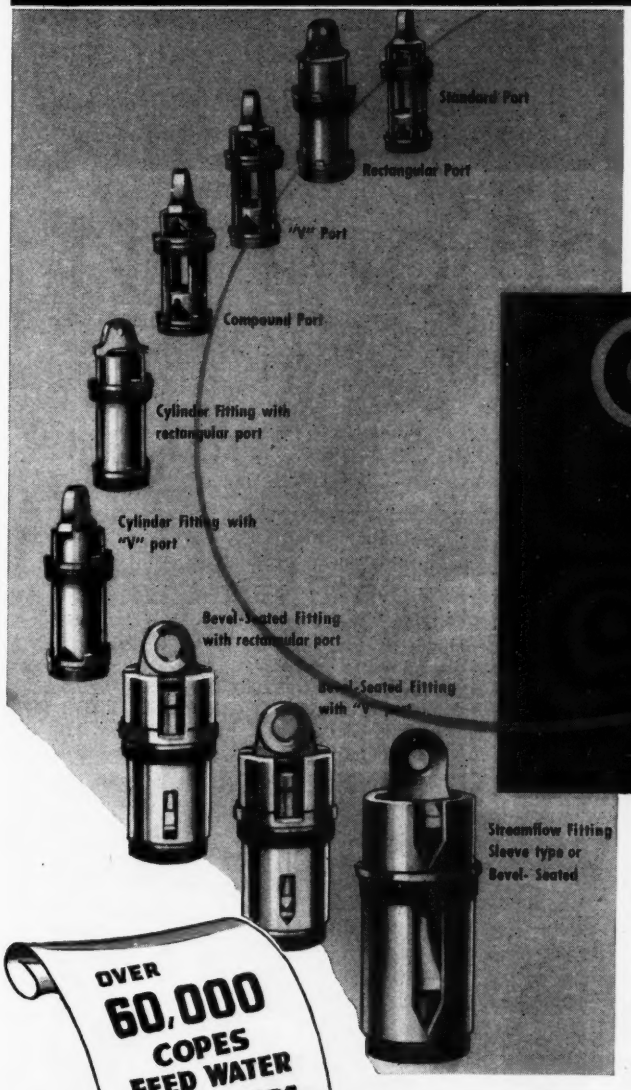
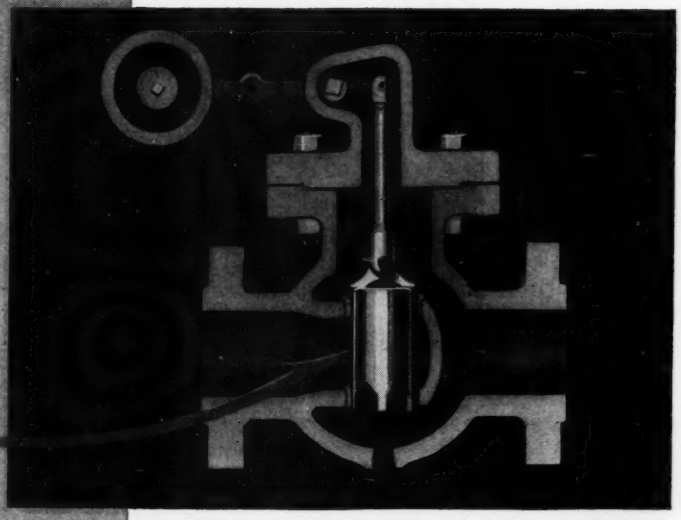
THAT'S WHY THE COPES BI-VALVE IS DESIGNED FOR THE BOILER IT SERVES



THE BI-Valve is as common to COPES Feed Water Regulation as is the familiar Thermostat. With 30 years of constant improvement and simplification, checked in over 60,000 applications, the BI-Valve is built to meet all boiler feed water requirements.

Out of several hundred exhaustive tests with as many different types of inner valves, we have learned which size of ports are necessary to give the proper imput to your boilers. They are tailored to meet specific operating conditions.



These "made to order" inner valves are one of the reasons for superior COPES performance—the closest relation between water imput and steam output—smoother charts.

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COPES — FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

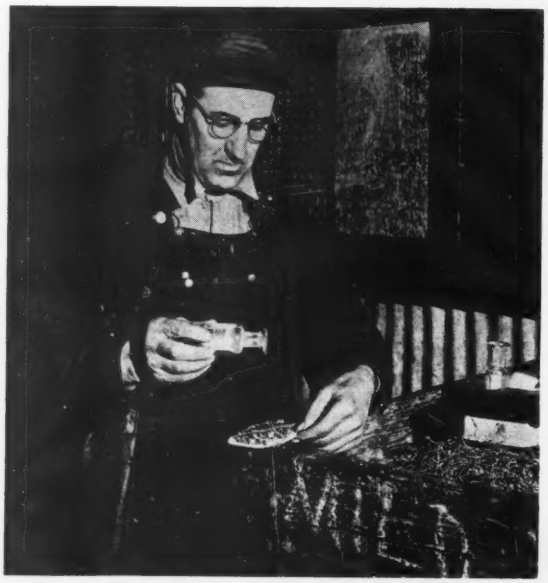
★ GET CLOSER LEVEL CONTROL WITH THE FLOWMATIC ★ REGULATOR

SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

FOR RIGGERS ONLY! Just in case you ever have to pick up a spider of this size, this is the way it is done. This one is for one of the 108,000 kw. units being installed for the Bureau of Reclamation at Grand Coulee Dam. Note six of the 12 arms had to be made in sections so it could be shipped over the railroads. Lowering the spider over the 4 ft. diam. turbine shaft is the first step in assembling the 587-ton rotor.

SOUND ABSORBERS. Testing airplane engines and propellers is a noisy task and this photograph shows Fiberglas thermal insulating wool used as a sound absorbing material in the "sound stacks" at an aviation engine test stand. Air entering and leaving the test cell is carried through these stacks and sound deadening is necessary not only to prevent an outside nuisance but to prevent deafness of the test crew. Sound absorbing materials used must: be fireproof; not pollute air with broken off particles; be impervious to gasoline, oil or water; cleanable by mechanical or solvents; withstand steam and freezing; be self draining; and must be able to withstand air velocities of above 100 m.p.h.



NICKEL IS SCARCE. Spot testing of turnings and scrap material for nickel content is simple. In the above photograph a workman at the Caterpillar Tractor Co. plant is making the test in the shop. Only nitric acid, dry zinc oxide, prepared test papers and a glass rod are needed. While simple, the procedure is too long to be covered here although complete directions are available upon request.

GOOD LIGHTING. Good work requires good lighting which unfortunately is not as common as it should be. This photograph shows a particularly well designed job in the tool shop of the Westinghouse Cleveland Works. Fluorescent luminaires arranged in continuous lines give a lighting intensity of 45 foot candles at the working level. The electric load is about 2.5 watts per sq. ft. of floor space.

MINIATURE FREQUENCY METER

PERMANENT MOUNT TACHOMETER

PORTABLE FREQUENCY METER

HAND TACHOMETER

PERMANENT MOUNT TACHOMETER

THESE STEEL REEDS are the Heart of all "FRAHM" Instruments

In appearance, these reeds may resemble a paper of matches . . . but there the similarity ends. They are the heart of all Frahm Instruments for measuring speed, frequency and rate of vibration and are the *only* moving parts.

Each reed of the Frahm Instrument, like a pitch pipe, is accurately tuned to a definite period of vibration, and a number of reeds with an appropriate interval between each are grouped in a housing to form a matched set. When minute vibratory impulses enter the reeds through the frame on which they are mounted, individual reeds come into resonance and clearly indicate the frequency of the vibration. Being essentially simple and rugged in construction, and since there are no rotating parts to wear, instrument accuracy is indefinitely maintained.

This resonant-reed principle is incorporated in all Frahm Tachometers and Frequency Meters. Instruments are made in both hand and permanent mounting types for speeds or rates of vibration in various ranges between 900 and 30,000 per minute, or frequencies from 15 to 500 cycles per second.

We will gladly send you full details on any or all of these "Frahm" resonant-reed instruments and their applications. The following bulletins are available on request:

Frahm Tachometers, Bulletin 1590PE
Frahm Frequency Meters, Bulletin 1695PE

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REFERENCE AND TRAINING CHART

CHEMICAL WARFARE AGENTS

PREPARED BY OFFICE OF CIVILIAN DEFENSE

CLASS	NAMES AND SYMBOLS	FORM	ODOR	PHYSIOLOGICAL EFFECT	TACTICAL CLASS	PROTECTION	FIRST AID (After removal from gassed area)	PERSISTENCE	FIELD NEUTRALIZATION
VESICANTS	MUSTARD $S(CH_2CH_2)_2Cl_2$ DI-CHLORETHYL SULFIDE	LIQUID AND VAPOR	Garlic, Horseradish, Mustard	Delayed effect. Burns skin or membrane. Inflammation respiratory tract leading to pneumonia. Eye irritation, conjunctivitis.			Undress; remove liquid mustard with protective ointment. Bleach pants, or kerosene; bathe; wash eyes and nose with soda solution.	One day to one week. Longer if dry or cold.	Cover with unslaked lime and earth. 3% solution of Na_2S_2.
VESICANTS	LEWISITE $ClCH{=}CHAsCl_2$ CHLOROVINYL-DICHLORARSINE	LIQUID AND VAPOR	Geraniums	Burning or irritation of eyes, nasal passages, respiratory tract, skin: Arsenical poison.			Undress; remove liquid Lewisite with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest—Doctor.	One day to one week. Longer if dry or cold.	Wash down with water. Cover with earth. Alcohol. RoGH spray.
VESICANTS	ETHYLDICHLORARSINE $C_2H_5AsCl_2$	LIQUID AND VAPOR OR GAS	Stinging, like pepper in nose	Causes blisters, sores, paralysis of hands, vomiting. Severe on long exposure.			Undress; remove liquid with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest—Doctor.	One hour.	Cover with earth, caustic.
LUNG IRRITANTS	CHLORINE Cl_2	GAS	Highly Pungent	Lung irritant.			Remove from gassed area. Keep quiet and warm. Coffee as stimulant.	10 minutes.	Alkaline solution.
LUNG IRRITANTS	CHLORPICRIN CCl_3NO_2 NITROCHLOROFORM	GAS	Flypaper, odor	Causes severe coughing, crying, vomiting.			Wash eyes, keep quiet and warm. Do not use bandages.	Open 6 hours. Woods 12 hours.	Na_2SO_3.—Sodium Sulfite in alcohol solution.
LUNG IRRITANTS	DIPHOSGENE $ClCOOC{-}Cl_3$ TRICHLOROMETHYL CHLOROFORMATE	LIQUID OR GAS	Ensilage, Acrid	Causes coughing, breathing hurts, eyes water, toxic.			Keep quiet and warm. Give coffee as a stimulant.	30 minutes.	Alkali.
LUNG IRRITANTS	PHOSGENE $COCl_2$ CARBONYL CHLORIDE	GAS	Musty hay, Green corn	Irritation of lungs, occasional vomiting, tears in eyes, dazed feeling. Occasionally symptoms delayed. Lotor, collapse, heart failure.			Keep quiet and warm, bed rest. Coffee as a stimulant. Loosen clothing. No alcohol or cigarettes.	10 to 20 minutes.	Alkali.
LACRIMATORS	CLORACETOPHENONE $C_6H_5CO{-}CH_2Cl$	SOLID OR GAS	Apple Blossoms	Makes eyes smart. Shut tightly. Tears flow. Temporary.			Wash eyes with cold water or boric acid solution. Do not bandage. Face wind. For skin, sodium sulphite solution.	10 minutes.	Strong, hot solution of sodium carbonate.
LACRIMATORS	BROMBENZYLCYANIDE $C_6H_5CH{-}BrCN$	LIQUID AND GAS	Sour fruit	Eyes smart, shut, tears flow. Effect lasts some time. Headache.			Wash eyes with boric acid. Do not bandage.	Several days. (Weeks in winter.)	Alcoholic sodium hydroxide spray.
STERNUTATORS	ADAMSITE $(C_6H_5)_2{-}NHAsCl$ DIPHENYLAMINECHLORARSINE	SMOKE GAS	Coal Smoke	Causes sneezing, sick depressed feeling, headache.			Keep quiet and warm. Loosen clothing. Remove. Spray nose with ephedrine or sniff bleaching powder. Aspirin for headache.	10 minutes	Bleaching powder solution.
STERNUTATORS	DIPHENYLCHLORARSINE $(C_6H_5)_2{-}AsCl$	SMOKE	Shoe Polish	Causes sick feeling and headache.			Remove to pure air, keep quiet. Sniff chlorine from bleaching powder bottle.	Summer 10 minutes.	Bleaching powder solution.
SMOKES	H C MIXTURE $ZN+C_2Cl_6$	SMOKE	Sharp-Acrid	Harmless.		None needed.	Produces no effect requiring treatment.	While burning.	None needed.
SMOKES	SULPHUR TRIOXIDE SO_3+SO_2HCl IN CHLOROSULFONIC ACID	SMOKE	Burning matches	Causes pricking of skin, flow of tears.			Wash with soda solution.	5 to 10 minutes.	Alkaline solution.
SMOKES	TITANIUM TETRACHLORIDE $TiCl_4$	SMOKE	Acrid	Harmless.		None needed.	Produces no effect requiring treatment.	10 minutes.	None needed.
INCENDIARIES	WHITE PHOSPHORUS P	SMOKE	Burning matches	Burning pieces adhere to skin, clothing.		None needed.	Pack in cloths wet with copper sulphate (blue vitriol) or water or immerse in water. Pick or squeeze out particles. Treat for burn.	10 minutes.	Burns out.
INCENDIARIES	THERMIT $8Al+3Fe_3O_4$	INCENDIARY	None	5,000 degree heat ignites materials.		None needed.	Treat for severe burn.	5 minutes.	Quickly cover with earth or sand.

GENERAL INSTRUCTIONS

The importance of proper first aid for gas victims cannot be overemphasized. The following are general rules which apply in all cases.

A. Act promptly and quietly; be calm.

B. Put a gas mask on the patient if gas is still present or, if he has a mask on, check to see that his is properly adjusted. If a mask is not available, wet a handkerchief or other cloth and have him breathe through it.

C. Keep the patient at absolute rest; loosen clothing to facilitate breathing.

D. Remove the patient to a gas-free place as soon as possible.

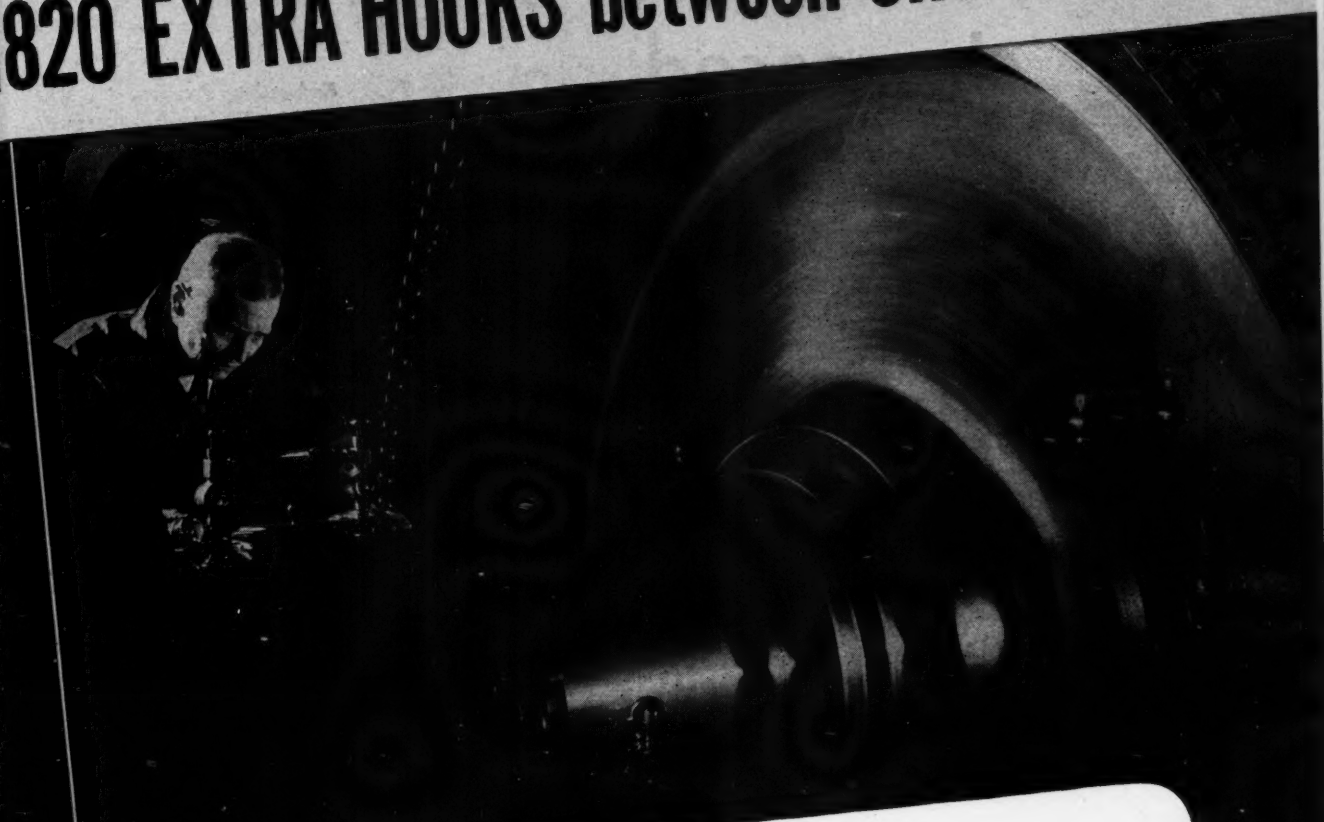
E. Summon medical aid promptly; if possible, send the victim to a hospital.

F. Do not permit the patient to smoke, as this causes coughing and, hence, exertion.

KEY

- HOSPITAL CASE
- FIRST AID TREATMENT
- SMOKE
- INCENDIARY
- MASK PROTECTION NEEDED
- FULL PROTECTIVE CLOTHING NEEDED

1820 EXTRA HOURS between "SHUTDOWNS"!



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Reduce Generator-Diesel "Time Outs" 50%

Before changing to Solnus Oil for lubrication, two 8-cylinder diesels, driving generators in a large institution, required overhauling at least twice each year . . . due to excessive formation of hard carbon.

Since the switch to Solnus Oils these diesels have been overhauled only once a year . . . are operating 1820 extra hours between shutdowns . . . and they haven't had a single piston ring failure due to faulty lubrication.

Sun Solnus Oils are the result of scientific research to develop an oil that will stand up in diesel service. They are wholly distilled, neutral in acidity, low in carbon content and extremely durable.

Let Sun Engineers—those Doctors of Industry—and Solnus Oils help you to achieve better diesel performance and lower maintenance costs . . . just as they have helped other diesel operators. Write . . .

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Softener Capacity Increased

Changes in manifold details result in salt economy, stopping zeolite loss in backwash and greater capacity of zeolite softener and can be applied to old units to bring their economy up to modern equipment

IN THE operation of zeolite water softeners one of the factors limiting the capacity of a unit has been that when attempts were made to increase softener capacity by increasing the depth of the zeolite bed, a large amount of the zeolite was washed into the drain while backwashing. Efforts to prevent this loss by employing a low flow rate when backwashing resulted in unsatisfactory cleaning of the zeolite bed. Also, packing and channeling of the bed resulted from continued use of low backwash flow which did not expand the zeolite bed sufficiently and uniformly. Thus the salt solution would not reach or regenerate the zeolite grains efficiently and the results were not entirely satisfactory.

This capacity limitation has been overcome by a change in the design of the Elgin Zeolite Water Softener Manifold System. This manifold system is not only used in the new type softener illustrated, but may be installed in any conventional zeolite softener now in use. It permits an appreciable increase in the depth of the zeolite bed without loss of zeolite during backwashing and at the same time steps up the efficiency of the softening operation, with the result that up to 44 per cent more capacity has been obtained, compared to that secured from a softener with conventional manifold system. The following explains the manner in which this is accomplished.

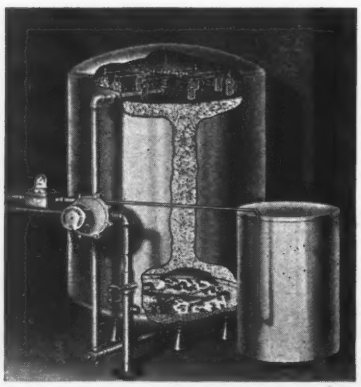


Fig. 1. Part section of zeolite water softener fitted with double check valves and strainers

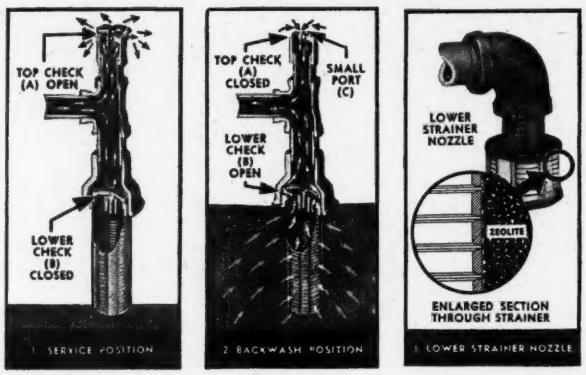


Fig. 2. Three detailed views of manifold assemblies illustrating principles of operation

At the outlets of the upper manifold from which the water to be softened is discharged to the zeolite softener bed and which serve as the discharge during the backwash period specially designed double-check valves assembled with strainers serve to close off the water passage to the strainer when water is being softened or salt solution is being introduced in this way preventing the strainers from being clogged with foreign matter. While in service the flow of the entering raw water opens the top check valve and closes the lower check. The ports in the top check give an even distribution of water over the entire bed so that a maximum softening effect will be obtained as the water passes uniformly down through the zeolite. These ports in the top check valves are also effective in distributing the salt solution. The strainers in the lower manifold are designed to prevent loss of zeolite during the service period yet permit free passage of water to the service line.

Backwashing Process

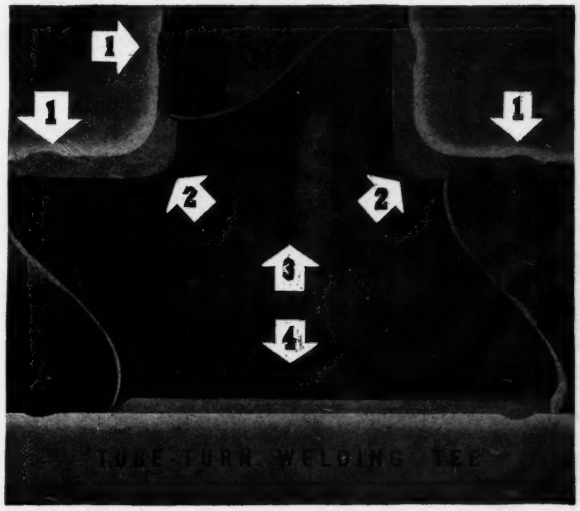
During the backwash process, the water issues at relative high velocity from the strainer nozzles in the lower manifold and is uniformly distributed as it passes up through the zeolite bed. When it reaches the upper manifold its direction of flow opens the lower check valve so that the backwash water can enter the upper manifold through the strainer assembly and pass to the drain.

Since the strainers prevent the escape of zeolite, the flow rate in backwashing can be much faster than is possible in a conventional zeolite softener. This faster flow rate thoroughly expands and cleans the zeolite bed, thus securing thorough contact between the zeolite grains and the salt solution during regeneration, and accomplishing this operation with less salt.

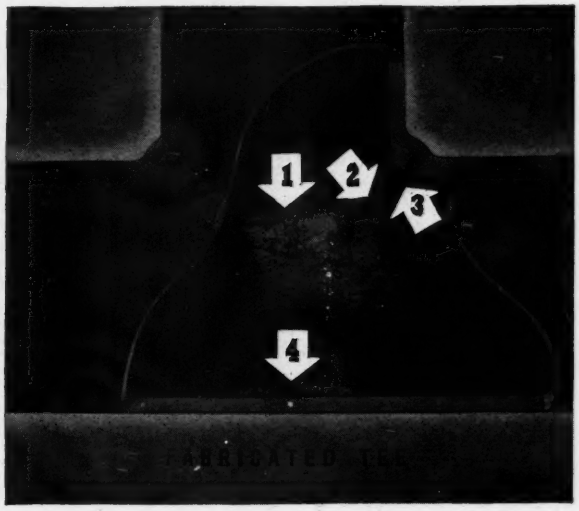
Suspended or floating impurities are discharged, during the backwash period, through small openings or ports through the top of the upper checks. The original fast backwash flow rate is so reduced by the strainers that the flow of water at the ports is too slow to carry out the zeolite yet is ample to carry out the foreign matter to the drain.

Thus by replacing the manifold system of the type usually employed in zeolite softeners with a double-check manifold system, greatly increased capacity can be obtained, zeolite loss prevented, packing and channeling of the zeolite bed prevented, more efficient softening and brining obtained, and the required amount of regenerating salt reduced.

Why TUBE-TURN WELDING TEES provide strong, safe, easy-to-weld branch connections

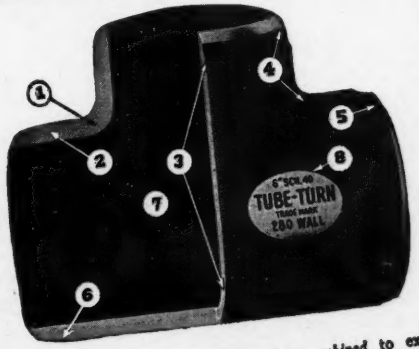


(1) Easy circumferential butt welds cut installation time, make sounder, safer joints. (2) Easy sweeping curves reduce friction and pressure loss to a minimum. (3) Smooth inside walls assure even flow and add to the long life of the connection. (4) No accumulation of slag.



(1) Joining a branch into a main with an intersection weld makes a weaker, less sound connection. (2) Gaps and irregularities caused by uneven cutting must be filled by welder. (3) Sharp corners and jagged angles are poor piping practices. (4) Possible slag accumulation can impede flow and seriously injure valves.

8 REASONS FOR SPECIFYING TUBE-TURN WELDING TEES



1 *Extra thickness at crotch* reinforces where highest stress occurs.

2 *Reinforcement along top of run* adds needed strength here.

3 *Reinforcement on sides*—also a point of high stress gradually tapers toward end of outlet and bottom of run.

4 *Longer outlet* permits faster lining up and ample room for rod manipulation.

5 *Ends machined* to exact pipe wall thickness—easy to align and weld.

6 *Increased bottom thickness* at full strength adds to weight without excess weight.

7 *Smooth inside walls, curved inner crotch and special manufacturing process* assure even flow.

8 *Size, material, thickness and name* identified on permanent name-plate.

COMPARE the two cut-away illustrations above point by point for *proof* of the unmistakable superiority of welding tees.

It takes *fewer man-hours and far less trouble* to install a Tube-Turn welding tee into a piping system than to fabricate a branch connection, a vital factor in today's plant expansion and modernization for war needs. Other major advantages of these seamless welding tees are the *greater strength, longer life,* and *smooth flow* secured.

The design and construction of Tube-Turn welding tees *add to the strength of the entire piping system* by reinforcing these crucial points.

Tube Turns manufactures a complete line of welding fittings and forged steel flanges in all standard sizes and weights. Write for new complete catalog and valuable engineering data book No. 111. It's free.

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TUBE-TURN
TRADE MARK
Welding Fittings

War Production Discussed at A.S.M.E. Fall Meeting

STIMULATED by the need for increased production of war materials, the attendance, nearly 500, at the Fall Meeting of the American Society of Mechanical Engineers, at Rochester, N. Y., October 12 to 14, was greater than could reasonably have been expected under present conditions.

The program built around the theme the engineer's contribution to the war effort, and the excellent work on the part of the local committee headed by Virgil M. Palmer in looking after the comfort of visitors, had much to do with the success and value of the meeting.

Reflecting the greatest needs of industry today, the most prominent sessions of the meeting had to do with management, education and training problems and production engineering. At the technical sessions papers were presented dealing with wood industries, fuels, aviation, applied mechanics, industrial instruments and materials handling.

Single Pool for Labor

Humphrey Mitchell, Canadian Minister of Labor, took time out from his regular duties to fly across Lake Ontario and address the engineers at the dinner meeting on the subject "Canada At War." He asserted as his studied opinion that, "all demands for men and women power must be met from a single pool. Different agencies cannot be permitted to draw upon the pool regardless of the needs of others."

Speaking as chairman of the Society's war production committee, James F. Walsh stated that actual comparison of United Nations and Axis weapons, "give promise we will outgun both the Germans and the Japanese. We have witnessed firings of the complete line of standard weapons and have no hesitancy in saying that, in our opinion, the weapons now used by the United States Army are at least the equal and in many cases the superior of weapons used either by Germany or Japan."

Train Women for War Work

The acute shortage of workers in the war industries was brought out in a round table discussion of "Women in Engineering." With so many of the men workers being called into the armed services, industry is turning to women to carry on work formerly done by men. "Too often," said Dr. Lillian M. Gilbreth, who has for years been an eminent authority on the subject, "the tendency of industrialists has been to decide a job question involving a woman on sex rather than efficiency." It is her opinion that there are numerous advantages to women to prepare themselves for engineering work. It satisfies the creative impulse, stimulates the war effort, facilitates maintenance of jobs for or with relatives, provides thrills, offers avoidance of less pleasant work, starts a career.

The growing importance of wood in industry was called to the attention of the engineers by Professor Nelson C. Brown of the State College of Forestry at Syracuse. He described wood as the most important raw material of the future. With some 800 items made of steel and other metals banned by the War Production Board, wood is being called upon to take their places and "is likely to be more important to civilization than metals, oil, rubber and ceramic products."

In relating experiences of the Rochester Gas & Electric Corp. in the use of electrostatic fly-ash precipitators, Irvin G. McChesney described the evolution in the design which took place up to the present installation which led to the following conclusions:

Substitution of punch-plate electrodes for the original rod curtain design increased precipitation efficiency. Hopper baffles are essential for the prevention of reentrainment of ash and subsequent loss of efficiency.

Gas flow to the precipitator should be distributed evenly across the inlet face with some reduction of velocity in the lower levels.

Breechings should be insulated on the outside sufficiently to protect them from weather and maintain metal temperatures above the dew point during operation.

Air should be admitted to idle breechings in sufficient amounts to suppress the dew point and prevent corrosion.

Ash should be removed at frequent intervals to prevent poor gas distribution to the precipitator.

Gas distribution should be a consideration in breeching design. Rapidly expanding sections leading to a precipitator are undesirable. Good distribution in right-angle bends is easily effected by the use of turning vanes.

Lag in Control Circuits

Contributing to the study of means for preventing time lag between the instant the actuating force is brought to bear upon an automatic control device and the time when conditions are corrected. J. G. Ziegler of the Taylor Instrument Companies and N. B. Nichols of the Massachusetts Institute of Technology presented a paper giving methods for quantitative determination of time lags in automatically controlled processes. They introduced a "recovery factor" term, part of a complete expression for controllability, which makes possible a classification of processes in dimensions of the process itself, regardless of controller or valve mechanism used.

WHAT THE OPERATOR WANTS TO KNOW

(Continued from Page 81)

1. Exceptionally careful supervision of control equipment is necessary if the plus or minus 10 deg. usually specified is obtained from the usual superheat control arrangement.

2. Designers must be accurately aware of operating conditions if a proper choice of equipment is expected. Feedwater temperature cannot change widely without affecting superheat.

3. Designers and operators must recognize the wide variation in conditions that usually exist in boiler furnaces and either arrange to control these conditions within narrow limits or specify and obtain especially flexible control apparatus if constant steam temperature is desired.

4. There are variables of stored heat and effects of load cycles and time which cannot be overcome or anticipated, and, therefore, the accuracy of temperature control in most cases is less than what some people expect and in some cases could not, under any circumstances, be obtained by design or control of operation.

HERE IS INDUSTRY'S ANSWER — TO THE *Gilmer* NATIONAL POWER-RECOVERY PLAN

"To say the least, the program which your Company has inaugurated towards the objective of conserving power in industry is intriguing and most timely."
Motor Div., General Electric Company

"We extend our congratulations on your National Power-Recovery Plan which is so well explained in the booklet."
Johnson & Johnson

" want to congratulate you upon your 'National Power-Recovery Plan' and its method of presentation "
Leeds & Northrup Company

I USE WHAT YOU LOSE

Typifying the reaction to the Gilmer National Power-Recovery Plan, the above comments give positive proof that Industry is awake to the danger of a power shortage, and recognizes the Plan as a practical stitch-in-time.

Approved by the WPB, the Power-Recovery Plan is offered absolutely free to industry, as Gilmer's contribution to the war effort. The "know-how" of leading power engineers has been incorporated in the Plan, and you'll find a wealth of technical information on each of the power services—Electricity, Steam, Mechanical Transmission, Compressed Air, Water, Refrigeration, Boilers, Prime Movers.

Enlist YOUR plant in this vital battle against power waste. And don't wait until power runs short . . . act NOW. Just send in the coupon, and the Plan will come to you promptly . . . all contained in one convenient booklet.

L. H. GILMER CO., Tacony, Philadelphia, Pa.

Gentlemen:

Please send us, without cost or obligation, a copy of the National Power-Recovery Plan, marked for the attention of:

NAME_____

FIRM_____

ADDRESS_____

Gilmer BELTS

L. H. GILMER COMPANY TACONY, PHILADELPHIA, PA.

War News From the Industrial Front

Coal, Oil Mixture for Industrial Furnaces

MIXING of oil and coal to produce a liquid fuel suitable for use in many industrial oil-burning furnaces has been suggested by the Bureau of Mines as one possible means of alleviating the current fuel oil shortage in the East.

On the basis of a preliminary investigation, the Bureau believes that many industrial furnaces could utilize this oilcoal fuel without material alterations in boilers and burners. It has been said and estimated that certain types of furnaces probably would save 30 to 35 per cent of the oil ordinarily consumed.

Coal Industry Hires Women

SOLID Fuels Coordinator Ickes said, October 13, that the coal mining industry, faced with a shortage of manpower, has begun to hire women to keep pace with the Nation's expanding wartime fuel requirements.

However, no instance has been reported yet where women are being substituted for actual mining or other underground work in American mines.

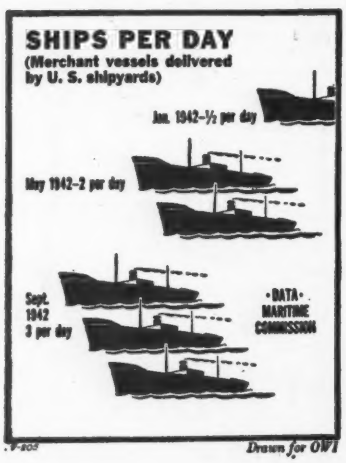
The coal mining industry has experienced a net loss of more than 50,000 men since January 1, according to surveys made by the Solid Fuels Office.

WPB Launches Drive for Industrial Scrap

A NATION-WIDE industrial "dormant scrap drive" has been organized by the conservation division of WPB, it was announced October 1 by Lessing J. Rosenwald, director.

Industrial executives will be asked to make an inventory of all dormant scrap materials and to make a complete disposal of all these materials through regularly organized scrap dealer channels as rapidly as possible.

Dormant scrap is defined as obsolete machinery, tools, equipment, dies, jigs, fixtures, which are incapable of current or future use in the war production effort because they are broken, worn out, irreparable, dismantled, or in need of unavailable parts necessary to practical reemployment.


SHIPS PER DAY
(Merchant vessels delivered by U. S. shipyards)
Jan. 1942-½ per day
May 1942-2 per day
Sept. 1942 3 per day
•DATA• MARITIME COMMISSION
Drawn for OWI

Petroleum Coke Limited to War Uses

DELIVERY and use of petroleum coke were restricted October 10 to certain essential war uses by Conservation Order M-212, issued by the director general for operations.

To direct the consumption of coke, into only those essential uses for which it is nonreplaceable, Order M-212 provides that no person shall use, deliver, or accept delivery of petroleum coke except:

1. Where it is to be incorporated into any of the 30-odd products specifically listed in the order, including graphite and carbon electrodes, anodes for aluminum, magnesium and alloy steel manufacture.

These permitted products are mostly electrical parts, silicon carbide abrasives, welding equipment, and a few other classifications.

2. In the treating of metals where the coke is a reducing agent for treating metallic oxides when WPB makes specific authorization for this purpose.

Conveyor Conservation Stressed

THE over-all importance of conveying machinery and mechanical power transmission to the war effort was emphasized October 8 with the issuance of Limitation Order No. L-193.

The order sets up machinery for scheduling production and makes mandatory the filing of monthly schedules with the WPB; it conserves engineering man hours by prohibiting engineering services, except with respect to authorized orders where the individual order amounts to more than $5000; orders under this amount are subject only to materials restrictions; and conserves critical material by imposing restrictions upon all orders, with certain exceptions.

Steel, Iron Makers Get Higher Repair Ratings

PRODUCERS of iron and steel, ferroalloys and blast-furnace coke will be permitted to use higher ratings during the fourth quarter for repair and maintenance supplies, it was announced October 3 by the director general for operations.

Such producers may apply ratings of AA-2X for operating material consisting of fabricated metal parts, lumber and all metals—ferrous and nonferrous—appearing on the revised materials list of Form PD-25A. Ratings of A-1-a may be applied to all other operating materials.

OPA to Speed Industrial Bituminous Coal Production

ACTION to speed production of industrial size bituminous coal urgently needed by the Army and War production plants, and to smash threatened bottlenecks in many soft coal mines was taken by the OPA.

Mine operators, under certain conditions, were authorized to crush lump, double screened, and "run of the mine" coal and sell this crushed coal at the maximum price for "run of the mine."

The new action was taken in Amendment No. 22 to Maximum Price Regulation 120 (Bituminous Coal Delivered from Mine or Preparation Plant), effective September 26.

Construction May Drop One-Third in '43

THE volume of all building and engineering construction—exclusive of shipbuilding—scheduled for the war program in 1943 will drop by more than a third, it was estimated by WPB.

At the present rate such war construction alone will reach a total of more than $11,000,000,000 at the end of 1942, topping the previous all-time record for all types of construction established in 1927 with a figure slightly less than $11,000,000,000.

Bayou Pipe-Line Nears Completion

CONSTRUCTION of the Bayou Pipe-Line System, part of the comprehensive pipe-line program to increase oil deliveries to the East Coast, is well under way and should be completed some time in December, it was announced October 5 by Petroleum Coordinator for War Ickes.

Additional pumping stations are being installed on the Plantation Line which will increase its capacity from 60,000 to 90,000 bbl. daily. Plans also are being made to extend the northern end of the Plantation Line from Greensboro, N. C., to Richmond, Va.

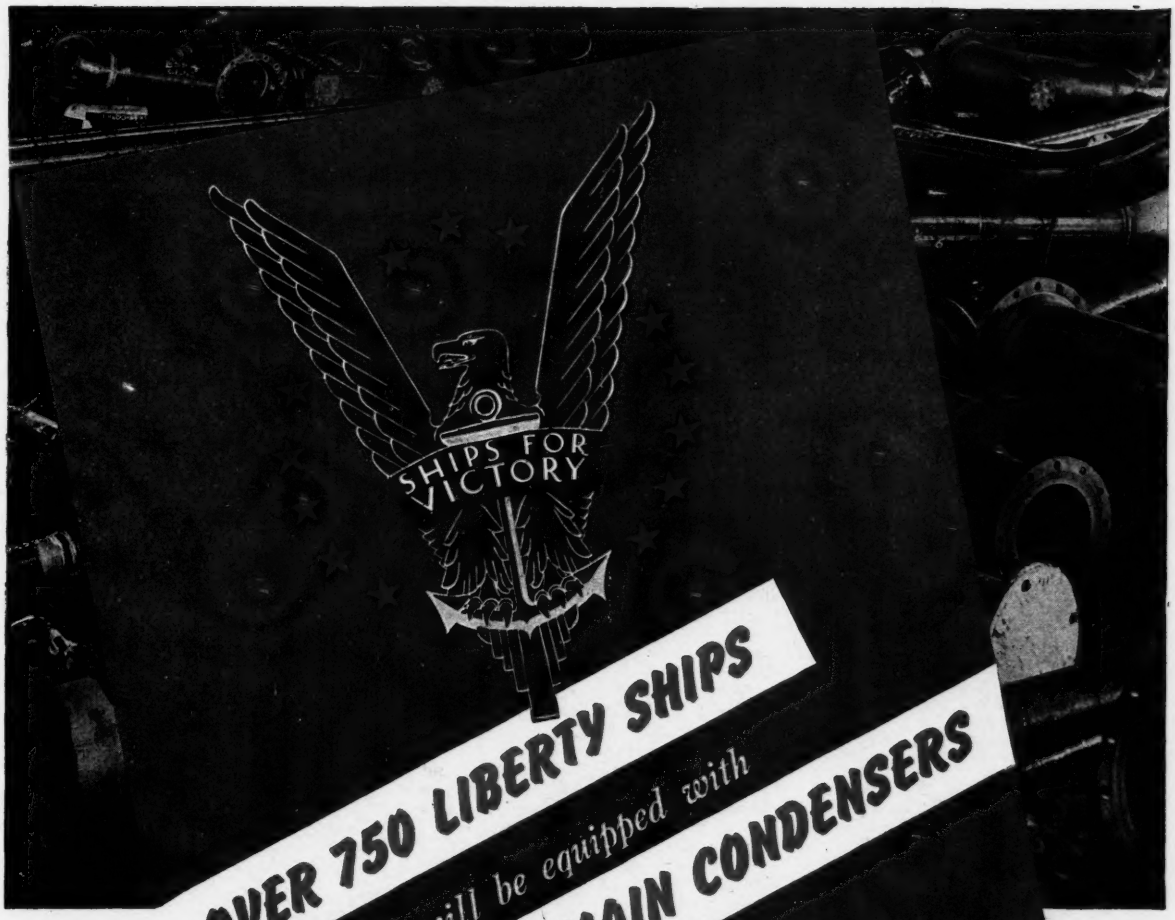
Midwest Fuel Oil Users Convert to Coal

UNLESS fuel oil users in the Midwestern States (District 2) convert quickly to coal or some fuel other than oil, wherever possible, "The supplies in that area will not be adequate," said Deputy Petroleum Coordinator for War Davies.

Explaining the critical shortage of fuel oil in the East Coast area, Mr. Davies mentioned the need of sharing supplies and transportation facilities between District 1 and 2.

He explained that the Midwest is the closest source of supply for the East Coast and that shipments from the Midwest area use a minimum amount of transportation facilities.

It is estimated that District 2 can save 20,000,000 bbl. of industrial fuel oils yearly by conversion, in addition to 2,500,000 bbl. of light fuel oils and an additional amount through conservation measures.



OVER 750 LIBERTY SHIPS

will be equipped with

KELLOGG MAIN CONDENSERS

HEAT TRANSFER DIVISION

THE M. W. KELLOGG COMPANY

JERSEY CITY, N. J.

225 BROADWAY, N. Y.

Aircraft Carriers and Destroyers use KELLOGG prefabricated High Pressure Piping

KELLOGG THE M. W. KELLOGG COMPANY
JERSEY CITY, N.J. • 225 BROADWAY, N.Y.
Representatives:
LOS ANGELES: 808 SOUTH GRAND • TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

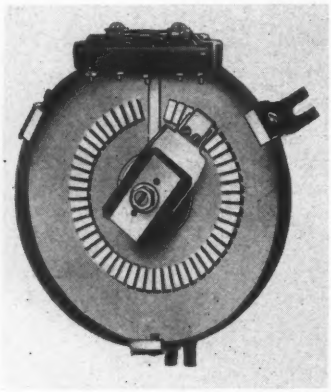
New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Rectangular Contacts for Steel Rheostats

PRESSED steel rheostats with solid rectangular contacts which are said to provide a finer degree of control and smoother operation where interpolating rheostats would otherwise be required have been announced by the Ward Leonard Electric Co., Mt. Vernon, N. Y.

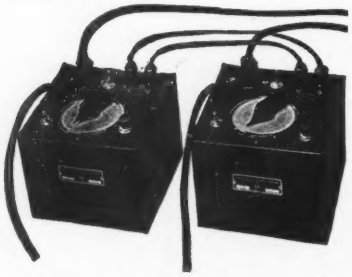
The rectangular contacts are available in small and large sizes. Small contacts can be furnished on 13-in. or smaller rheostats and large contacts can be furnished on 8-in. or larger rheostats.



The rheostats with the contacts can be furnished with complete enclosures, fittings for conduit connections, motor drives and with accessories for floor, back-of-board, and concentric mounting. Fixed and adjustable stops to protect control equipment can also be provided.

Electronic Timer

AN ELECTRIC timer designed for single actuation as well as for sequence timing and recycling in continuous operation has been announced by the Photovolt Corp., 95 Madison Ave., New York, N. Y.



The function of the timer is to close or open an electrical circuit for a preset time interval. It has an adjustable timing relay with immediate automatic resetting for timing periods from 1/20 sec.

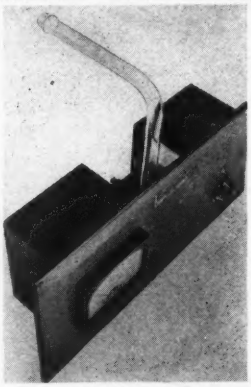
To permit the possible switching operations which may occur in actual timing work, the timer is constructed so that powered and unpowered loads can be switched simultaneously. It can also be actuated by either push button or remote control, and is available in a crackle finished steel casing.

Continuous-Flow Colorimeter

THE Lumetron Colorimeter Model 400-S, announced by the Photovolt Corp., 95 Madison Ave., New York, N. Y., is designed to register the light transmission of a liquid passing continuously through the instrument.

The operating principle of the instrument is similar to the one of the usual type of photoelectric colorimeters: The light of an incandescent lamp passes through a color filter and through the liquid, then, it impinges upon a barrier-layer photocell the current of which is registered by an electrical indicating instrument.

The distinctive feature of the Continuous-Flow Colorimeter lies in the liquid under test passing through a glass tube rather than being contained in an absorption cell or a test tube. This makes the instrument suitable for the continuous control of chemical



processes in which the color or turbidity of a liquid must be checked either as a measure of its concentration or as an indication of some other chemical or physical condition. Once calibrated by means of a solution of known concentration, the instrument indicates the concentration directly and continuously, obviating the necessity of taking samples and analyzing them at regular intervals.

The instrument is designed to be mounted on a panel or control board.

The Colorimeter is available for 105-125 v., 50-60 cycle a.c.; with constant voltage transformer and built-in color filter, and also other currents.

Portable Hydraulic Test Bench

A PORTABLE hydraulic test bench that can be used for pre-flight c'.ecking of the hydraulic circuit of planes before leaving the ground, is announced by the Hydraulic Machinery, Inc., 10421 Grand River, Detroit, Mich. The testing includes putting the plane through all of its hydraulic functions without running the plane motors. Its equipment consists of a hydraulically operated air compressor (high or low-pressure) for the purpose of charging hydraulic accumulators. It can also be used to pump

hydraulic fluid in and out of the plane. A variable displacement pump permits the unit to operate hydraulic circuit at different speeds. It has an adjustable pressure range of 0 to 1000 psi. All of the controls are labeled and easily accessible from the outside of the unit. Provided with a hardwood top, mounted vise and built-in drawer, it is a combination portable hydraulic work and test bench that can be wheeled to any part of an aircraft plant or field.

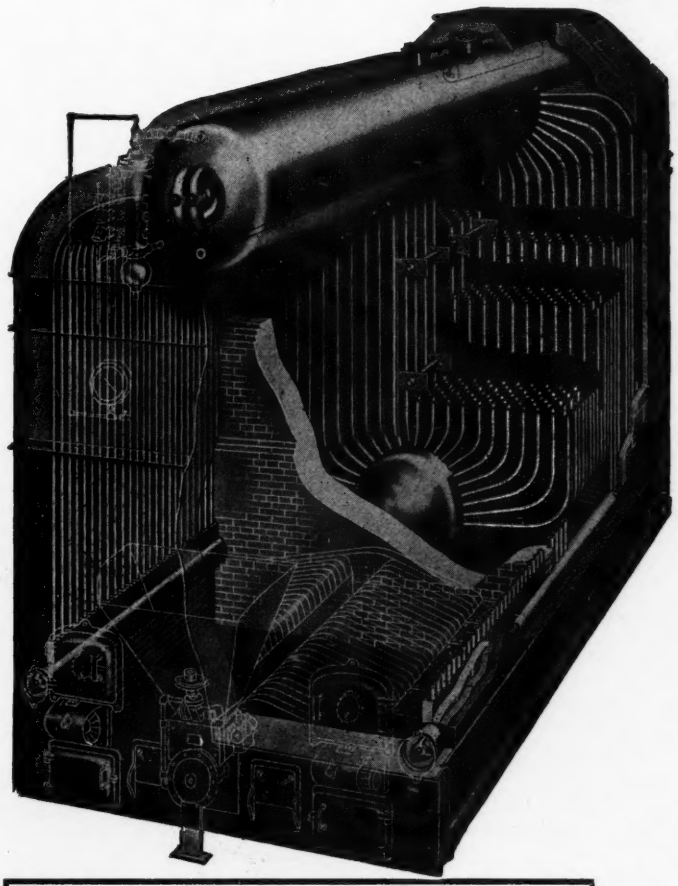
Pump Standardization

AMERICAN ENGINEERING Co., Philadelphia, Pa., announces completion of a standardization program on 16 sizes of their Hele-Shaw fluid power pumps.

Standardization affects pumps in both the low-pressure and high-pressure ranges, including pump capacities of 0.25, 0.4, 0.75, 1.5, 3, 6, 9, 12 and 18 in the high-pressure series, of 0.25, 0.4, 1.5, 4, 7, 12 and 18 in the low-pressure series.

Standardization enables the company to increase production, improve deliveries in the face of procurement difficulties, and make replacements of completed units and replacement parts available promptly. Hele-Shaw Pump Controls have also been standardized, reducing the number of control sizes and increasing their application to a greater number of pumps.

Don't Buy Now!



Unless:

1 You are engaged in essential war production,

2 Your present equipment is inadequate,

3 You desire to operate more efficiently,

4 to lose less time for repairs,

5 to spend less money for maintenance,

6 to get more capacity in a given space,

7 to handle overloads when they occur.

All of these advantages can be obtained by the use of the Keeler C P steam generator, over eight hundred of which are now in use, serving important industries and institutions throughout the United States and Canada.

Capacities to 100000# per hour
Pressures 125# p.s.i. to 500# p.s.i.
Suitable for firing with stokers, pulverizers, oil, gas, bagasse, hogged fuel or waste heat.

(Manufactured in Canada by Canadian Vickers, Ltd., Montreal)

E. KEELER CO.
BUILDERS OF BETTER BOILERS SINCE 1864
WILLIAMSPORT, PENNA.

E. KEELER CO., WILLIAMSPORT, PENNA.
Established 1864

Send copy of Bulletin FS-2 to

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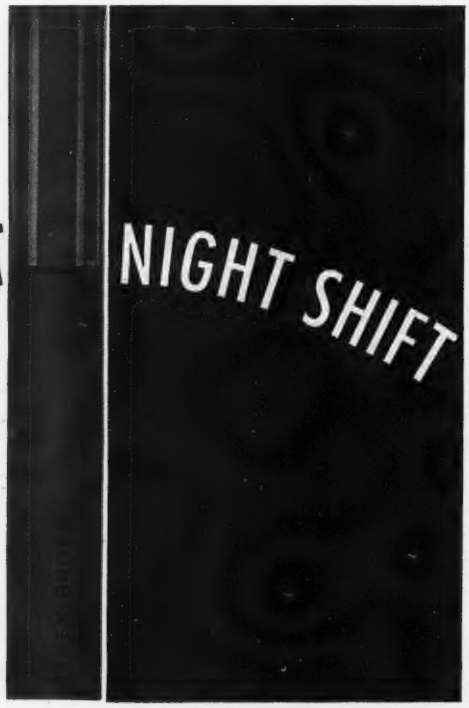


A reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

THE WATER LEVEL ALWAYS STANDS OUT

Fill a PYREX Broad Red Line Gauge Glass and any ordinary gauge glass each half full of water. Next, compare them at any distance. Then and there you will discover why PYREX Broad Red Line Gauge Glasses are favorites of both day shift and night shift engineers.

If you can see a PYREX Broad Red Line Gauge Glass, you can see the water level.

The transparent broad red line—fused into the wall of the gauge glass itself—shows up brilliantly under either front or rear illumination.

Both the brilliance and transparency of PYREX Broad Red Line Gauge Glasses are permanent, for these glasses are resistant to the corrosive attacks of steam and water. Resistance to thermal shock enables them to stand up under sudden temperature changes. And the machine-drawn accuracy of the glasses decreases installation strains.

PYREX and CORNING brand Gauge Glasses are stocked by all leading mill and steam supply dealers.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

Plastic-Covered Conduit

A NEW type of flexible, plastic-covered conduit, Amerflex, has been announced by Searle Aero Industries, Inc., Orange, Cal. The use of a plastic covering instead of rubber for insulation helps reduce the weight of the conduit, an important advantage for airplane designers. Amerflex is used

principally in planes, tanks and boats to protect the electrical assembly from gasoline and oil.

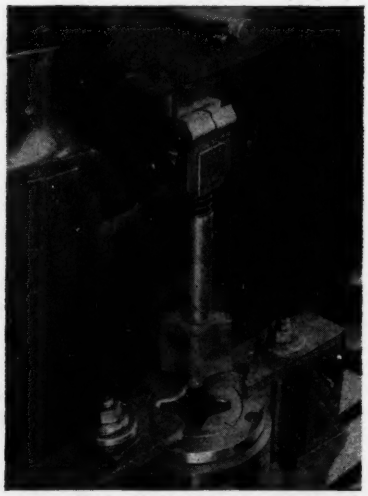
The plastic skin over flexible metal conduit protects the conduit itself and the wires inside against wear, abrasion, heat and most solvents.

Amerflex plastic-covered conduit is made in sizes from 3/16 in. I.D. to 1¼ in. I.D. and is said to withstand brittleness at sub-zero temperatures, also having a high dielectric and tensile strength.

Lapping Slotter

DESIGNED to eliminate inaccuracies of hand lapping, the Universal Slotmaster was recently announced by the Experimental Tool & Die Co., 12506 Greiner, Detroit, Mich.

The lapping arbor is mounted in the standard clapper box tool holder of the Slotmaster and is gradually worked into the die opening aided by pressure from a coil spring. The operation is started by lowering the lapping arbor to the mouth of the die opening and then setting



the down-stroke of the slotter so that it will completely compress the spring, which is mounted between a shoulder on the shank of the lapping arbor and the tool holder. The spring then gradually relaxes and the lapping arbor works its way into the opening, as a result of the spring pressure and the stroking of the slotter. When the spring is completely relaxed—the down-stroke of the slotter

POWER transmitted along slipping, inefficient drives rapidly becomes wasteful —causes undue expense and decreases machine capacity.

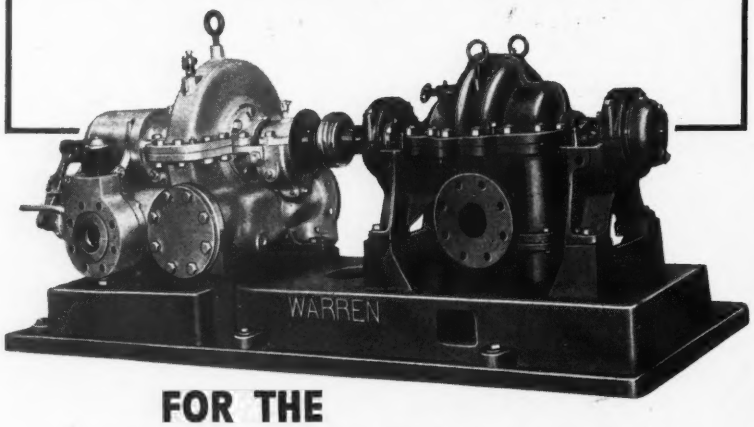
With the Morse Chain Drive principle—"Teeth Not Tension"—there is no chance for slip or power waste. All the power is turned into productive war action at practically 100% efficiency. Every Morse Drive is a completely engineered power transmission unit so selected and designed as to render unfailing service in the severest of conditions. There is no need for constant adjustment, inspection—Morse Drives operate for years requiring hardly any maintenance. To keep war production at maximum, specify Morse Chain Drives—your local Morse Drive Engineer will assist you.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

WARREN PUMPS HAVE "THE GUTS"



FOR THE TOUGHEST JOBS IN YOUR PLANT

It takes real "guts" to stand up under today's gruelling production schedules—and Warren Pumps have got plenty of what it takes. They were designed, engineered and constructed to work 24 hours a day, 7 days a week—*year after year.*

The records that Warren Pumps are establishing for performance and economy are possible because Warren Pumps have *good details.* Consider a few: liberal clearances between impeller and case rings . . . extra-heavy shafts . . . over-size bearings . . . broad-faced case rings . . . properly proportioned liquid passages.

Get in touch with our engineering department if you have a pumping problem. Remember—"A Warren Recommendation Is Never A Compromise."

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

is again set up to completely compress the spring and the operation is repeated until the full length of the opening in the die has been lapped.

Remote Control Unit for Welders

HOBART BROTHERS Co., Troy, O., has recently developed a new remote control unit for welders which is protected from accidental breakage by a metal pull-out handle set over the control dial and by cushion springs on the back of the porcelain rheostat.

The new dial is said to increase weld qualities—especially welds made under modern high-speed techniques. It is well known among operators that for best results, welding heat should be increased somewhat when using coated electrodes in changing from flat position to vertical or overhead positions, and vice versa. Operators are, however, tempted to get by without changing machine adjustment because such changes involve repeated trips between work and machine.

With remote control, this condition is eliminated, because it places 100 steps of fine volt-amperage adjustment right within reach of the operator's hand. The remote control unit is easily set up by using an ordinary lamp cord extension to connect it to the machine. On other jobs, welding machines may be compactly located near the ceiling to conserve floor space, while the operators located below the machines use the remote control for fine current settings.

The large outer control dial is the field rheostat which controls the differential compounds—while the remote control unit adjusts the open circuit voltage. 1000 combinations of voltage and current are said to be possible with this Hobart Multi-Range Dual Control Dial.

Liquid Temperature-Signaling Medium

A NEW addition to the line of Tempil thermometric products has been announced by Tempil Corp., 132 West 22nd St., New York, N. Y. The new product, called Tempilaq, is available in a wide range of predetermined melting points between 125 and 1600 deg. F.

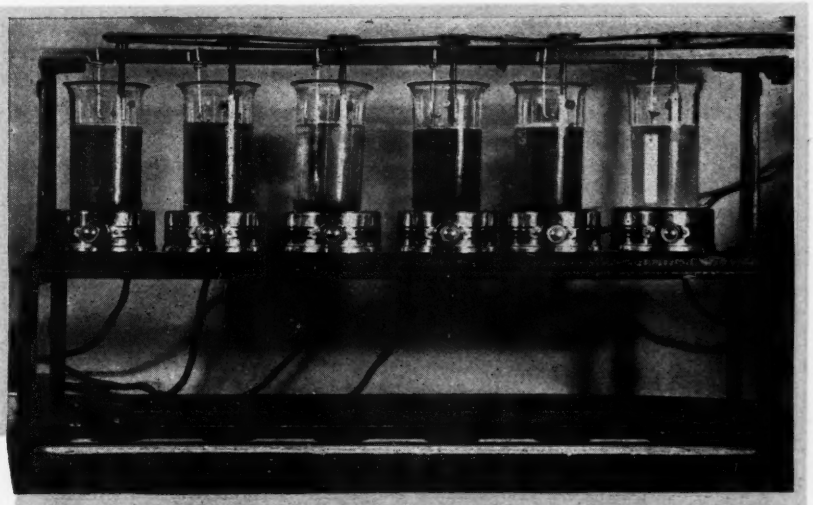
Application is simple. A thin smear or daub of Tempilaq is applied to the working surface and dries in an instant. When the temperature stated on the bottle is reached, the smear liquefies and on cooling it solidifies, leaving a glossy or vitreous mark which is distinctively different from the original smear.

Being a liquid, Tempilaq can be used on glass, wood, ceramics or plastics as

★

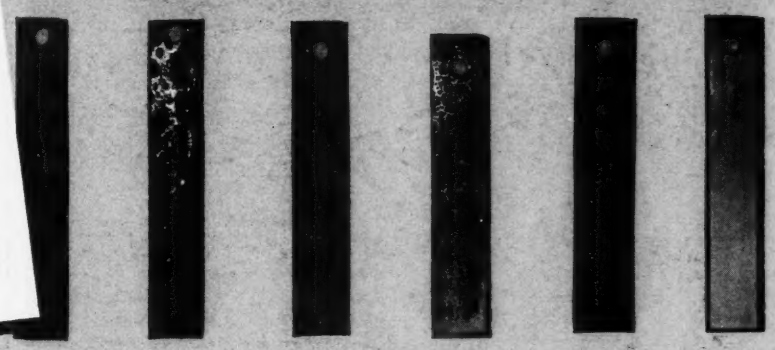
(This test was described in a Shell Turbo Oil advertisement dated January, 1941)

★



The Turbine Oil that PREVENTS Rust!

These six steel test strips prove Shell Turbo Oil positively prevents rusting. All six strips were immersed for 48 hours at 167° F. in well-known turbine oils, mixed with 10% of distilled water and continuously agitated at 1200 R. P. M. Right-hand strip, immersed in Shell Turbo Oil under these severe test conditions, shows no rust. All of the other strips rusted badly.



PUBLISHED by the AMERICAN SOCIETY FOR TESTING MATERIALS AS TENTATIVE STANDARD . . .

a turbine oil rusting test

AT ITS 1942 ANNUAL MEETING, the American Society for Testing Materials adopted as tentative standard D665-42T, a turbine oil rusting test similar to that shown above.

Here is *official* recognition of the importance of the rust-preventive effect of modern turbine oil! For more than two years, the superiority of Shell Turbo Oil in preventing rust has been consistently proved by the test illustrated.

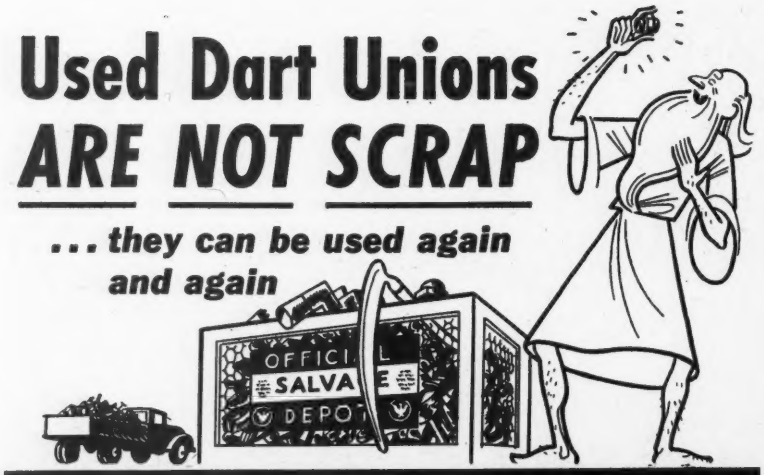
Two other features of Shell Turbo Oil, *high oxidation stability*, and *minimum foaming tendency*, make it equal to every requirement of modern turbine lubrication.

SHELL

SHELL TURBO OIL

Used Dart Unions ARE NOT SCRAP

... they can be used again and again



Get in your scrap . . . *every bit.* BUT be careful not to turn in used DART UNIONS . . . because even though Darts have seen extensive service, they are capable of going back on the job with tight-joint performance.

Sounds almost too good to be true? Not when you realize that Darts have always been *made* to be used time and again . . . and to resist rough handling. Darts have matched bronze seats, ground to "true-ball" surfaces . . . and Dart bodies and nuts are made of air-refined malleable iron just so that Dart Unions *can* give you this extra service.

Try *your* used Darts . . . and if you need new ones, see your supplier today.

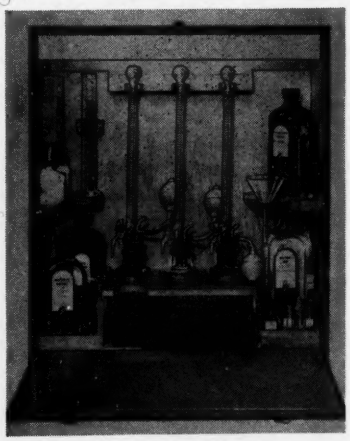
DART UNIONS

E. M. DART MFG. CO., Providence, R. I.

well as on metal, polished surfaces, the inside of tubes or castings and in other inaccessible places such as overhead surfaces.

Water Testing Equipment

A NEW series of Water Test Sets has been announced by W. H. & L. D. Betz, Gillingham and Worth Sts., Philadelphia, Pa. These "A" Series Test Sets include the necessary chemicals and apparatus for determining hardness, alkalinities, chlorides, phosphates and sulfites in water, when any two, three or four of these tests are required. A special cabinet designed for use on table or wall is provided. All chemicals and apparatus are



contained in the cabinet, held in a secure position and ready for instant use. A portion of the opened cabinet door forms a convenient acid-resistant laboratory work table, and a fluorescent light provides correct illumination for the tests. The protection afforded by the cabinet minimizes breakage and eliminates errors caused by dust or dirt.

Crane and Load-Carrying Truck

A NEW Elwell-Parker Elec. Co., Cleveland, O. power industrial transportation unit is said not only to perform the separate functions of a load carrier, a crane and a tractor but also combines the typical operations of all three.

As a load carrier the mobile unit has an unobstructed platform 84 in. long by 40 in. wide by 25 in. high, with a rated capacity of 6000 lb. As a crane handling up to 2000 lb. at 42 in. on the

CAST IRON FLANGES

CAN BE SUCCESSFULLY SUBSTITUTED IN MANY PLACES

The war demands for forged steel flanges are greater than the ability of the shops to supply them. And the steel required is badly needed for other war production. The result is a rapidly developing "bottleneck" in much essential piping.

Cast iron flanges, on the other hand, are usually available on suitable priorities. Cast iron screwed and lap-joint flanges can be substituted with complete satisfaction in many places where operating conditions do not exceed 250 p.s.i. pressures and saturated steam temperatures.

As a part of its war effort, the Pipe Fabrication Institute has made a study to determine where such steel-saving substitutions will be advantageous. Member fabricators are ready to make recommendations on cast iron flange substitutions which will not impair piping quality.

Qualified pipe fabricators can help you get your piping more quickly . . . and at the same time give maximum cooperation to the war effort.

THE PIPE FABRICATION INSTITUTE

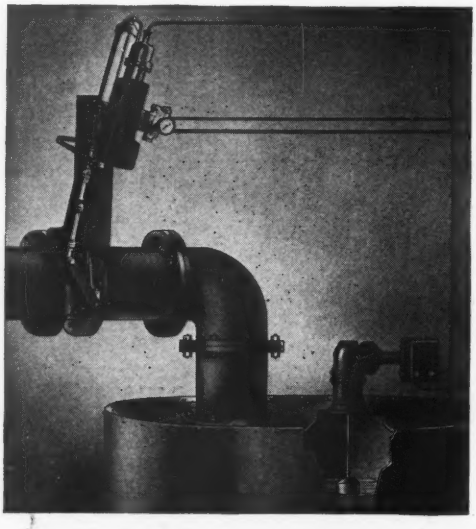
Devoted to the Technical and Economic Problems in Piping

1108 CLARK BUILDING • PITTSBURGH, PA.

How R-S Butterfly Valves are applied to Liquid Level Control

The Butterfly Valve is controlled automatically by the tank float and is actuated by the hydraulic power cylinder attached to the valve.

The use of an R-S Butterfly Valve as a main control valve *simplifies* the performance of the system because of the minimum pressure drop, unexcelled flow characteristics, wedge-tight shut-off and reduced maintenance. Holds the level within close limits. Used for pressures between absolute and 600 pounds gauge.



R-S Butterfly Valves provide *simplified* control and wedge-tight shut-off of volume and pressure for air, steam, oil and other liquids—in fact, any material that flows or is forced through a pipe. Constructed to withstand high temperatures and pressures to 600 pounds.

Write for detailed information and Catalog No. 10-B.

Direct action float control for low working pressure. Can be furnished with counter weight assembly or larger floats as required.

BUTTERFLY VALVE DIVISION

R-S PRODUCTS CORPORATION

4535 Germantown Ave. Philadelphia, Pa.

R-S Streamlined BUTTERFLY VALVES

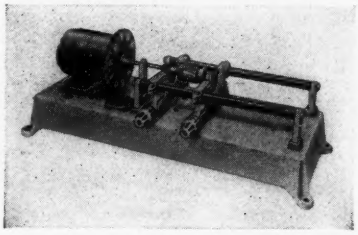
boom, it lifts and transports castings or other heavy, bulky objects. As a tractor, it first loads the trailers by means of its own crane, then hauls them at speeds up to 5 m.p.h.

The truck operates with 2-wheel drive and 4-wheel steer. The frame is made up of heavy section formed plates welded into a rugged one-piece structural unit embodying the control dash and the boom is of special design, of heavy formed channel members rigidly reinforced with tie rods, lattice bars and gusset plates and slews around a 3½ in. diameter alloy steel pillar. Thrust load is taken on oversize ball bearings at the base of column; radial loads on roller bearings at both top and bottom.

Balancers

DY-NAMIC Balancing designed to eliminate the noise and premature wear of shafts, bearings, etc., resulting from the excessive vibrations of rotating parts caused by couple action has been recently announced by the Bear Mfg. Co., Industrial Division, Rock Island, Ill.

These machines embody a new sensitive and accurate balancing principle and are said to be easy to operate. They are also said to indicate the disturbing centrifugal force or force couple with a high degree of accuracy. Both the angular position and the value or amount of unbalance is shown at the same time.



With these balancing machines, it is unnecessary to static balance before a test can be made. The balancing machine reveals whether a static or Dy-Namic unbalance, or both, are present without reversing ends of the body being balanced.

The balancing machines are available in a variety of models ranging from bench models to large floor and pit-type models for balancing such rotating parts as armatures, fans, blowers, flywheels, hubs, drums, propellers, gears, impellers, pulleys, wheels, rotors, etc., weighing from 6 oz. to 1000 lb.

Portable Pressure Gage Tester

COMPACTLY designed for checking all types of mounted pressure gages in service without removing them from their panels or mountings, the Grove Gage Comparator permits service gages to be quickly and accurately checked "in-place" without breaking line connections, as announced by the Grove Regulator Co., Oakland Cal.

Equipped with three precision laboratory test gages, accurate to within ¼ of 1 per cent of full scale, the comparator will check various ranges of pressure gages from 0 to 1000 lb. Necessary testing pressures are supplied from built-in high-capacity air cylinders, which can be charged and recharged as often as required with any

How to Repair Valves
TO GET RENEWED LIFE FROM GATE AND GLOBE VALVES
TO CONSERVE CRITICAL METALS
NEW VALVES FOR OLD
PLEASE CHECK AND PASS ON
POST ON SHOP BULLETIN BOARD
AN AID TO VICTORY
What to Do in Repairing Leaky Gate Valves
How to Regrind or Renew Disc and Seat in Globe Valves
How to Renew Disc in Composition Disc Valves

A "BEST TELLER" FOR PIPING MEN

Look at the timely subjects covered in "Piping Pointers" Bulletin No. 5. What is more important to piping men—NOW—than knowing how to repair valves for better and longer service—to keep war production lines flowing—to conserve metals! We don't know of any other current source of such vital information.

"Piping Pointers" are designed to help you train men for the big maintenance job that faces industry at war. Their content is fully accurate and practical—it's based on Crane Co.'s vast experience as America's leading producer of valves and fittings. Even veteran workers use "Piping Pointers" to keep up-to-date.

FREE TO ANY PLANT

In "Piping Pointers," Crane shares its basic information with all industries producing for Victory. This service is *absolutely free,* yet countless plants have testified to its inestimable value in maintenance shops and employee training schools. If you're not using "Piping Pointers" now, let your Crane Representative arrange for your supply.

Five "Piping Pointers" Bulletins have been published to date. To meet the demand, extra supplies of all editions have been printed. Get the entire series now—*when you need them* most. *First come first served.*

CRANE

CRANE CO., GENERAL OFFICES:
836 SOUTH MICHIGAN AVENUE, CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

FOR...
ARCHES
ASH PITS
BAFFLES
BRIDGE WALLS
BURNER BLOCKS
DOOR LININGS
STOKER SETTINGS

USE EASY-TO-GET CASTABLE REFRACTORIES

Jointless walls and arches are quickly cast in place, special shapes easily molded, with these ready-to-use mixtures of refractory aggregates and LUMNITE.

POWER PLANT operators keep Castable Refractories in stock for general refractory work, for emergency repairs and for making special shapes without delay.

Refractories without delay—today that's an important advantage of a Castable Refractory. You can take a bag of the dry castable, mix it with water and cast it in place. You need only a simple form for your wall or arch, a home-made mold for your special shapes. A Castable Refractory made with LUMNITE is ready for service within 24 hours after mixing.

Note these advantages of Castable Refractories:

No cutting or fitting. The Castable Refractory takes the shape of the form, mold or frame.

No ramming. After mixing with water the material is cast and simply tamped in to consolidate it.

Practically no shrinkage in drying or firing. No allowance need be made for shrinkage or expansion.

Unaffected by moisture, steam. High resistance to spalling.

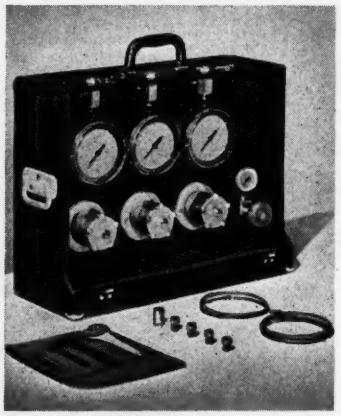
▶ To get these advantages and to be assured of performance, power plant engineers specify Castable Refractories made with LUMNITE. When you buy a LUMNITE Castable Refractory, you get a ready-to-use, balanced refractory—the result of careful selection of the most suitable refractory aggregates and the hydraulic binder which made Castable Refractories possible.

Castable Refractories of different types to meet different temperature and insulation requirements are made by manufacturers of refractories and are sold by their distributors throughout the country.

The Atlas Lumnite Cement Company
(United States Steel Corporation Subsidiary)
Chrysler Bldg., N. Y. C.

Specify **CASTABLE REFRACTORIES**
MADE WITH LUMNITE

clean, dry gas, air or oxygen. The fine degree of pressure control is made possible by three Grove pressure loaders mounted below each test gage. The loader serves as an accurate pressure reducing valve with built-in automatic

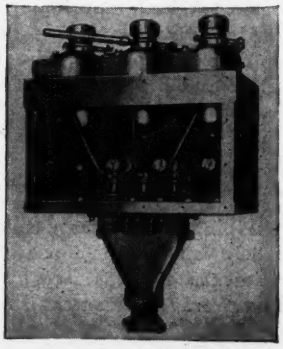


relief. Because of its large diaphragm-to-valve area ratio, it provides positive pound-by-pound controlled and maintained accuracy of delivery pressures, whether increasing, decreasing or constant.

Metal-Enclosed Oil Fuse Cutouts

A NEW metal-enclosed assembly of gang-operated oil fuse cutouts for economical short-circuit protection and switching has been announced by the General Electric Co., Schenectady, N. Y.

The new cutout assemblies permit totally metal-enclosed installations, either single or 3-phase. They save installation labor because each unit is factory-assembled with flexible, insulated cable leads ready for connection to either single or multi-conductor cable. The leads enter the individual cutouts above the oil level, thus preventing loss of oil. Switching requires merely throwing a lever 90 deg. Fuse carriers can be removed without disturbing the gang-operated mechanism.



The new assemblies are adapted for use (indoor or outdoor) in industrial plants for branch circuits, individual transformers or banks, motors, control apparatus, and electric-heating and other equipment.

The new assemblies can be supplied for wall or direct-to-apparatus mounting, with openings for conduit, cable, or pothead connections.

Save CRITICAL METALS by using IRON BODY VALVES

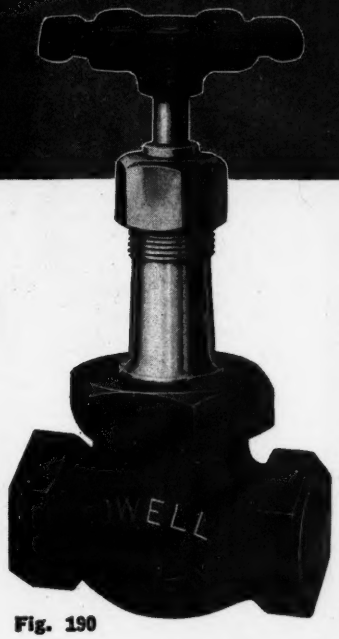


Fig. 190

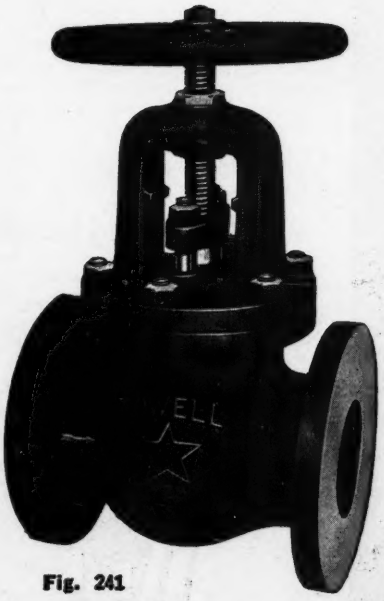


Fig. 241

Switch to POWELL Iron Body Valves wherever possible

Not so long ago many buyers and users of valves automatically thought of bronze. It was accepted as the standard for many installations . . . apparently the impression existed that the desired service could not be obtained if any other metal were used.

But—that was before Pearl Harbor!

Today, with copper and tin high up on the critical metals list, the use of the more available metal becomes urgent. Research and recent experience have proven that iron valves—especially properly designed and sturdily built POWELL Iron Valves—will, in many instances, serve just as effectively as bronze valves.

Therefore, when you specify POWELL Iron Valves you not only render a patriotic service by helping to conserve the now critical copper and tin, but you can expect quicker delivery because of the lower priority rating required. And—you'll have EXTRA SAVINGS TO INVEST IN WAR BONDS.

The Wm. Powell Company

Dependable Valves since 1846

Cincinnati, Ohio

Fig. 190—Iron Body, Bronze Mounted "Irenew" Globe Valve for 150 pounds W. S. P. Has screwed ends, Union bonnet and regrindable, renewable hard bronze seat and disc. Available in sizes from ¼" to 3", inclusive.

Fig. 241—Iron Body, Bronze Mounted, Standard "Model Star" O. S. & Y. Globe Valve, with flanged ends, outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Made in sizes from 2" to 12", inclusive, for 125 pounds W. S. P.

POWELL VALVES

Asphalt Bituminous Coating Seal

CARBO SEAL COAT, designed for use in the sealing of asphalt or bituminous coatings which are used for waterproofing, and which in many cases will not permit the application of light colored coatings without a bleeding-through by the asphalt, is announced by the Carbozite Corp., First National Bank Bldg., Pittsburgh, Pa. Carbo Seal is said to seal off the asphalt or bituminous coating, preventing this bleeding.

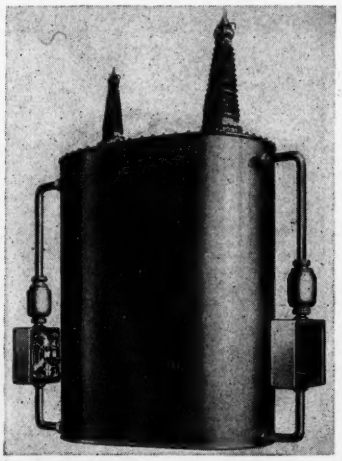
After the emulsion coat has been applied it is necessary to allow the coating to dry for approximately two or three days before putting on the finish coatings and it is recommended that the finish coatings be applied in a manner to produce a minimum amount of disturbance to the seal. This is done by brushing on the finish coat lightly or by the spraying method.

Transformer Cooling System

VITALLY needed increases in power transformer capacities can now be obtained with a new system of forced-oil cooling that is said to save 25 per cent in critical war materials on new transformers. The new cooling unit, announced by the Allis-Chalmers Mfg. Co., Milwaukee, Wis., called the Electro-Cooler, is said to step up capacity of transformers already in service by about 20 to 60 per cent.

The Electro-Cooler consists of a radiator-type cooler and a special pump with motor enclosed. These are connected by piping to the standard radiator valves at the side of the transformer. No stuffing boxes are required in the special pump, and the motor is self-cooled and self-lubricated.

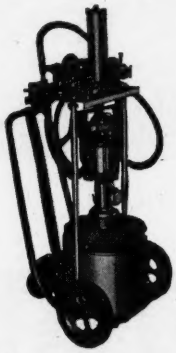
Because the new cooling unit is relatively small, usually more than one is required, the number depending upon the size of the transformer.



A wartime development designed to save copper and steel, the Electro-Cooler is expected to have wide use in post-war applications also. For the current emergency, it can be built into new transformers and be readily applied to transformers already in service. If the transformers are equipped with the conventional type radiator valves, installation can be made in 3 to 4 hr. without removing the oil in the transformer.

Portable Forced-Induction Pump

A NEW addition to its line of pile drivers is announced by the Lincoln Engineering Co., 5701 Natural Bridge Ave., St. Louis, Mo. This is the "50" Series



portable forced-induction pump which can be used wherever it is necessary to move the unit from one location to another.

DIRTY BOILER TUBES ARE ENEMY SABOTEURS

Now, when boilers must develop every pound of steam possible from the fuel burned, it is imperative that tubes be cleaned *cleaner* and *faster* than ever before. Dirty boiler tubes slow up production of essential war materials just as surely as enemy saboteurs working on the production line.

Wilson Tube Cleaners, cutter heads, brushes or other accessories clean *any* mechanically cleanable ferrous or non-ferrous straight or curved tubes of large or small diameter *better* and *faster*. Their use *reduces* tube cleaning time and *increases* steam pressure and plant production.

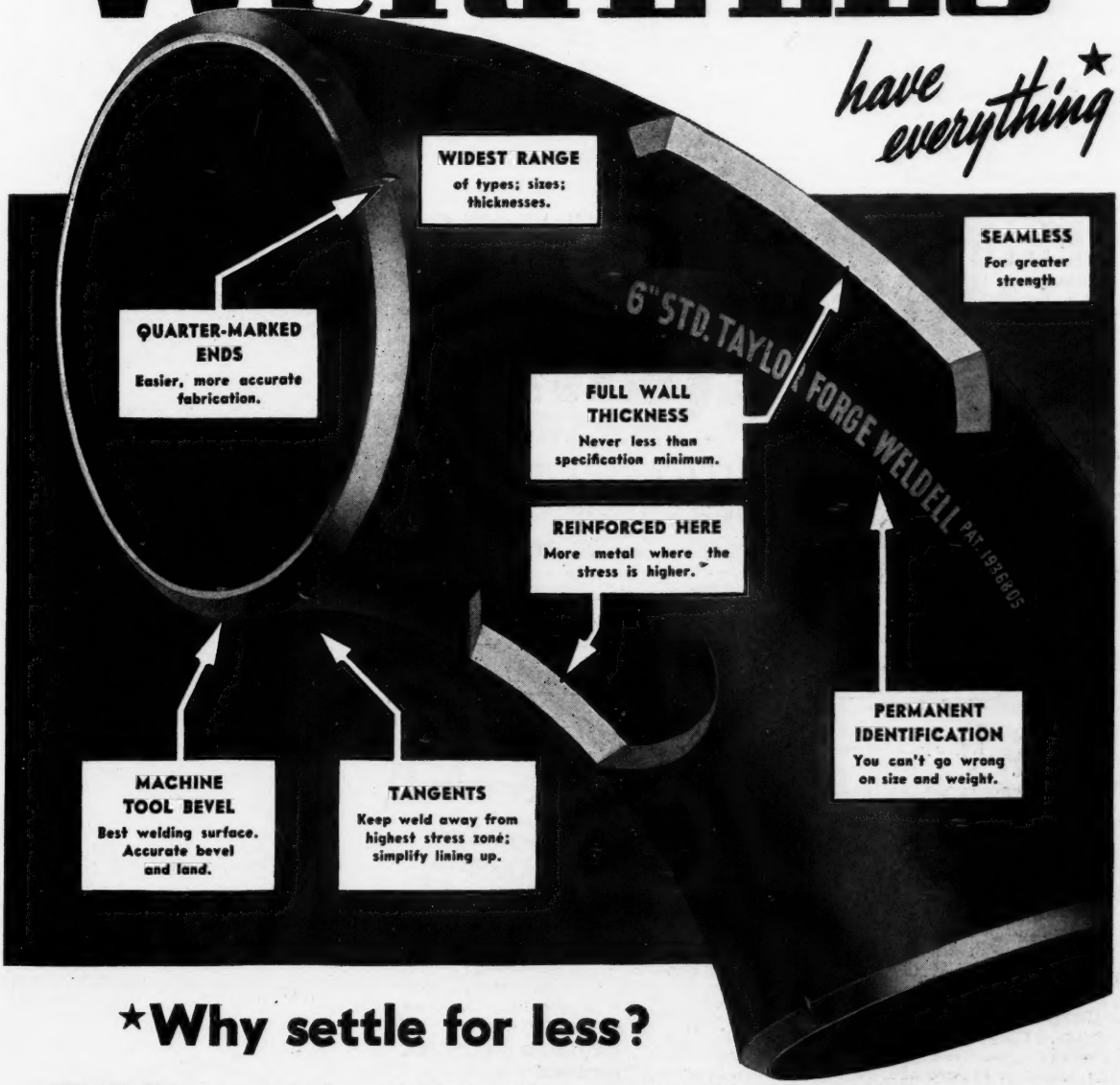
Every Wilson Tube Cleaner and accessory is especially designed and built for a specific job of tube cleaning. That's why it does its work so remarkably well and with such unusual speed. You can get the *proper* tube cleaning to meet the exact tube conditions existing in *your* plant. Write for the name of our representative nearest to you or ask for a copy of our NEW forty-page catalog which fully describes and illustrates the complete line of Wilson tube cleaning equipment.

INVEST IN AMERICA! BUY WAR BONDS AND STAMPS!

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47 28 37th Street Long Island City, N. Y.

WeldELLS

have everything ★


WIDEST RANGE
of types; sizes; thicknesses.
SEAMLESS
For greater strength
6" STD. TAYLOR FORGE WELDELL PAT. 1976605
QUARTER-MARKED ENDS
Easier, more accurate fabrication.
FULL WALL THICKNESS
Never less than specification minimum.
REINFORCED HERE
More metal where the stress is higher.
PERMANENT IDENTIFICATION
You can't go wrong on size and weight.
MACHINE TOOL BEVEL
Best welding surface. Accurate bevel and land.
TANGENTS
Keep weld away from highest stress zone; simplify lining up.

★Why settle for less?

WHAT do you seek in that welded piping job? Speed? Economy? Sound engineering to meet extreme conditions? What?

Of course any one of these considerations may slightly out-rank any other, depending on the nature of the installation. But the fact remains that every one of them is mighty important to *every* job.

That's why it pays to use the welding fittings that are designed down to the last detail to meet all requirements of every job. With features that are combined in no other welding fittings, WeldELLS give you the means of doing any job as *well* as it can be done—as *easily* as it can be done—and therefore as *economically* as it can be done.

A number of these features are pointed out above. Some provide engineering advantages; others reduce installation time and cut costs. Combined, they give you the extra value that distinguishes WeldELLS. Why accept less than the Welding Fittings that have *"everything"?*

TAYLOR FORGE & PIPE WORKS

General Offices & Works: Chicago, P.O. Box 485 • *New York Office:* 50 Church Street • *Philadelphia Office:* Broad Street Station Building

Embodying the principle of forced-induction priming, it is said that this pump can pump materials such as sealing compounds, sound deadeners, insulating materials, putty, viscous grease, heavy lubricants, etc., directly from the original container to the point of application.

Substitutes for Rubber in Strippings

ANNOUNCED by Felt Products Mfg. Co., 1530 Carroll Ave., Chicago, Ill., is a new strip material with the spongy effect of rubber strip to be used as a substitute for critical materials formerly utilized in gaskets and strips.

The Fel-Pro Thiokol strip material, produced by the application of Thiokol to a specially processed felt base, is said to make it weather resistant. Utilized on army vehicles for such uses as tailgate moulding, it is also applicable to numerous industrial applications.

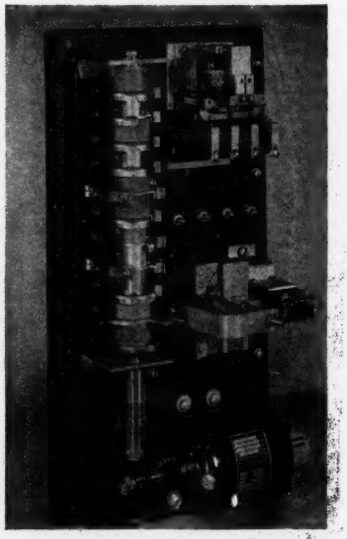
Blackout Lamp

BLACKOUT lamp, designed to provide a quick, easy and economical method of supplying sufficient illumination for ease of movement during blackouts, is announced by Sylvania Electric Products, Inc., Lighting Division, Salem, Mass. The lamp is an A-15 type bulb, coated black except for a 1-in. aperture in the bulb end which emits an orange-red light. Having a 14-w. filament, the blackout lamp is available in two voltage ranges: 115-125 v. and 30-34 v.

Synchromatic Relay

A NEW STA synchromatic relay for field application for more satisfactory synchronous motor starting, is announced by the Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

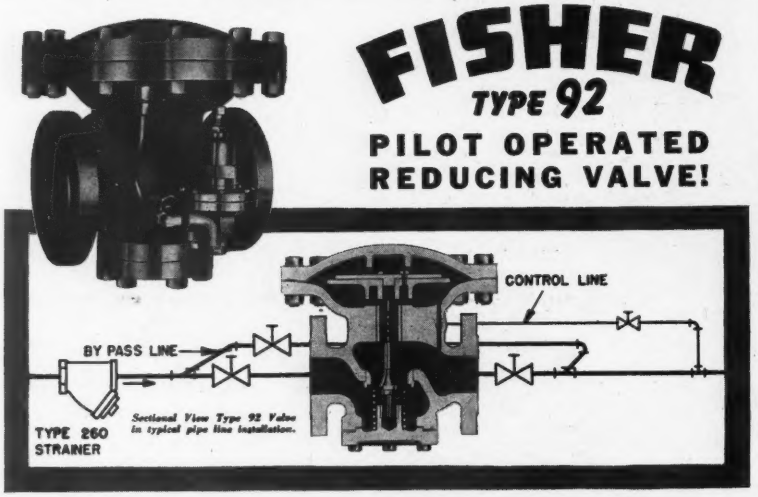
The relay consists of two elements, one that is speed responsive, and the other time responsive. The speed responsive element is a current relay and the time responsive element is a rotary drum switch. Both elements are simple in design and of rugged construction.



The synchromatic relay meets the six basic requirements for synchronous motor control; maximum nonsynchronous speed attained before field application, minimum power required because synchronizing is never attempted before maximum speed is attained, synchronizes in minimum time consistent with maximum speed, positive synchronizing sequence, minimum line disturbance because of favorable rotor position, and automatic pull-out protection.

The synchromatic relay is compactly designed either for panel mounting or modern dead front, metal enclosed, swing door type control structure.

DESIGNED ESPECIALLY FOR STEAM PRESSURE CONTROL!



● The Fisher Type 92 has become the logical choice of engineers for dependable steam pressure control for these reasons . . .

ACCURATE

Pilot control — with its extreme sensitivity to flow changes — maintains the desired reduced pressure with remarkable accuracy. No auxiliary pilot operating medium is needed.

COMPACT

Modern Fisher Engineering has produced in the Type 92 Valve a compact controller with unusually large capacity. Available in 10 sizes from ½" to 2" screwed or 1" to 6" flanged. No special wrenches are required for servicing.

FLEXIBLE

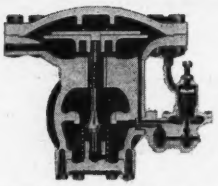
Two pilot assemblies for high or low pressure service are available and interchangeable on all Type 92 sizes. Pilot control spring easily adjusted or changed to obtain a variety of reduced pressure ranges.

STURDY

High-tensile bodies and diaphragm casings are of extremely rugged, ribbed construction. Inner parts are of Duromite bronze or stainless steel. Every construction detail designed to assure maximum trouble-free service.

SHUT-OFF

Single port construction provides tight shut-off on dead end service.



Type 92 sectional view showing cross section of pilot assembly.

REDUCED PRESSURE RANGES

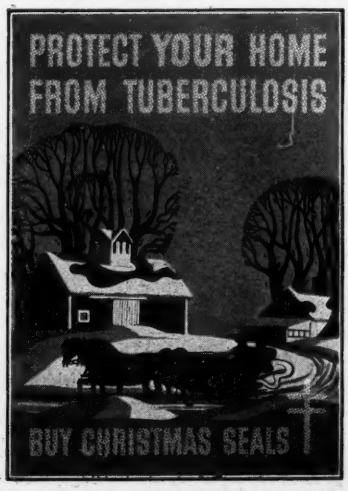
Pounds per square inch, with low pressure pilot: 2-6, 4-10; with high pressure pilot: 5-30, 60-130, 25-70, 120-200.

MAXIMUM INLET PRESSURES

Screwed Ends:
250 lbs., 410°F.
Standard Flanged:
*125 lbs., 360°F.
Extra Heavy Flanged:
250 lbs., 410°F.
* 6" Size — 100 lbs., 340°F.

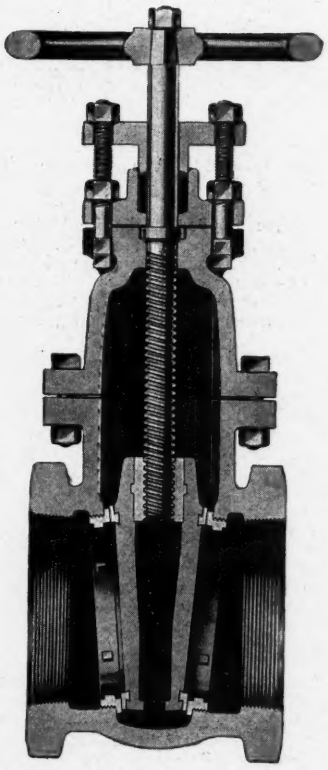
WRITE FOR BULLETIN C1

FISHER GOVERNOR COMPANY
1011 Fisher Bldg., MARSHALLTOWN, IOWA



STRONG EFFECTIVE DURABLE

OPERATING MECHANISMS and BODIES



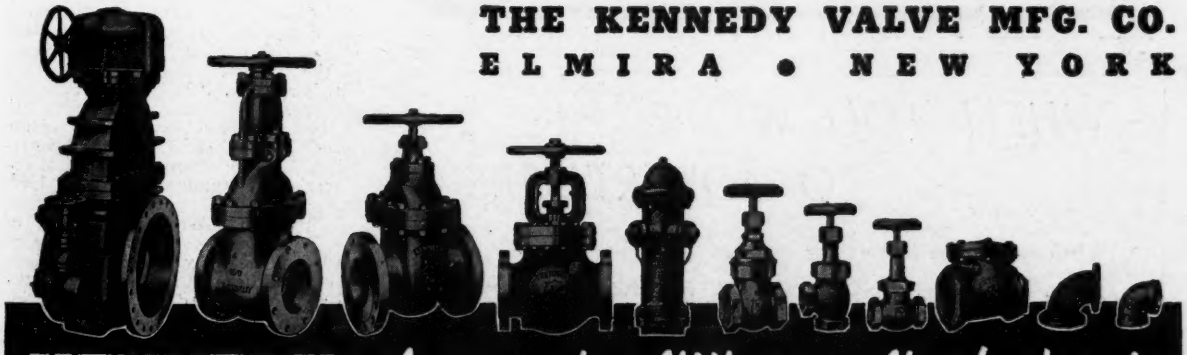
Let your eye follow the operating mechanism of this Iron Body Kennedy Standard Non-Rising Stem Screwed Wedge Gate Valve.

First, notice the large handwheel for ample leverage. Then look at the heavy stem and the sturdy proportions of the wedge disc mechanism.

Notice, too, the thick sections of body and bonnet, the bronze bushings at all stem contact surfaces, and the many little refinements of design that provide strength and lasting security. The outside screw and yoke valves of this type have many special conveniences, too, for easier repacking and manipulation.

You can obtain Kennedy Valves in a wide range of sizes and pressures, with screwed or flanged ends and with non-rising stem or outside-screw-and-yoke. For full description, send for the 40-page Kennedy Catalog.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK



KENNEDY *valves... pipe fittings... fire hydrants*

Safer Boiler Operation
Easier Maintenance with ERNST FITTINGS

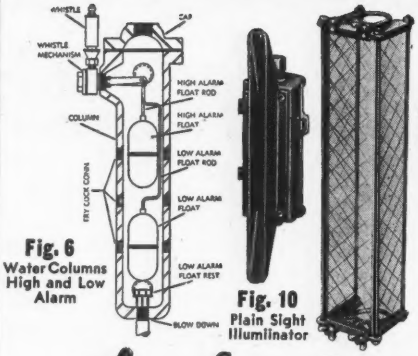


Fig. 6
Water Columns High and Low Alarm

Fig. 10
Plain Sight Illuminator

Fig. 72-3
Inclined Split-Gland Adjustable Water Gages, No Gage Glass Packing Nuts

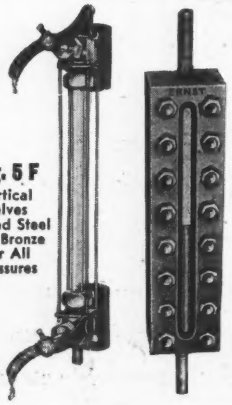


Fig. 5 F
Vertical Valves Forged Steel and Bronze for All Pressures

Fig. 9
Wire Glass Better-C Guards, All Sizes

Fig. 13
Leakless Cocks, Bronze and Forged Steel

Fig. 45
"C-Clear Thru" Flat Glass Inserts

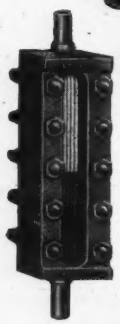


Fig. 37
C-BLACK Prismatic Flat Glass Inserts

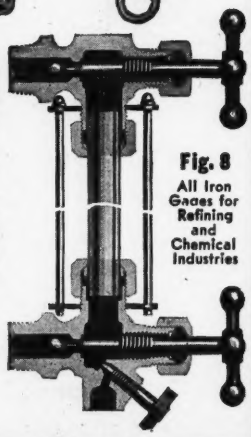


Fig. 8
All Iron Gages for Refining and Chemical Industries

For Immediate Quotations, send us sketches or blue prints of your requirements, along with quantities needed. Highest quality material and workmanship to meet your specifications.

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J. Phone: Livingston 6-0276

WHEN YOU WRITE TO ADVERTISERS

When writing advertisers for catalogs, descriptive bulletins or prices, please remember to say, "I saw your message in POWER PLANT ENGINEERING." Thus you'll do a good turn for the advertiser and for this publication. . . . . .

MANUFACTURERS' PERSONALS

Bailey Meter Co. announces the appointment of L. F. Richardson as branch manager of its newly established Los Angeles office and H. T. Sawyer as branch manager of its new Seattle office. V. A. Rumble, manager of the company's San Francisco branch office, continues as West Coast Supervisor.

A. C. Thalacker, a member of the Detroit Rex Products organization since 1937, has been named general manager of the company. He will handle the new duties in addition to his work as secretary. Mr. Thalacker, born in Wisconsin in 1907, is a graduate of the University of Wisconsin.

The Wilkening Mfg. Co., Philadelphia, Pa., recently elected Warren K. Lee vice-president of the company.

Mr. Lee has been a member of the company for over 10 yr. His headquarters will be at the Lexington Bldg., Detroit, Mich.

Recent changes in the Union Iron Works, Erie, Pa., include, E. T. Knobloch, who was elected president and general manager; R. E. Sevin, vice-president and sales manager; E. E. Knobloch, treasurer; O. E. Henning, secretary.

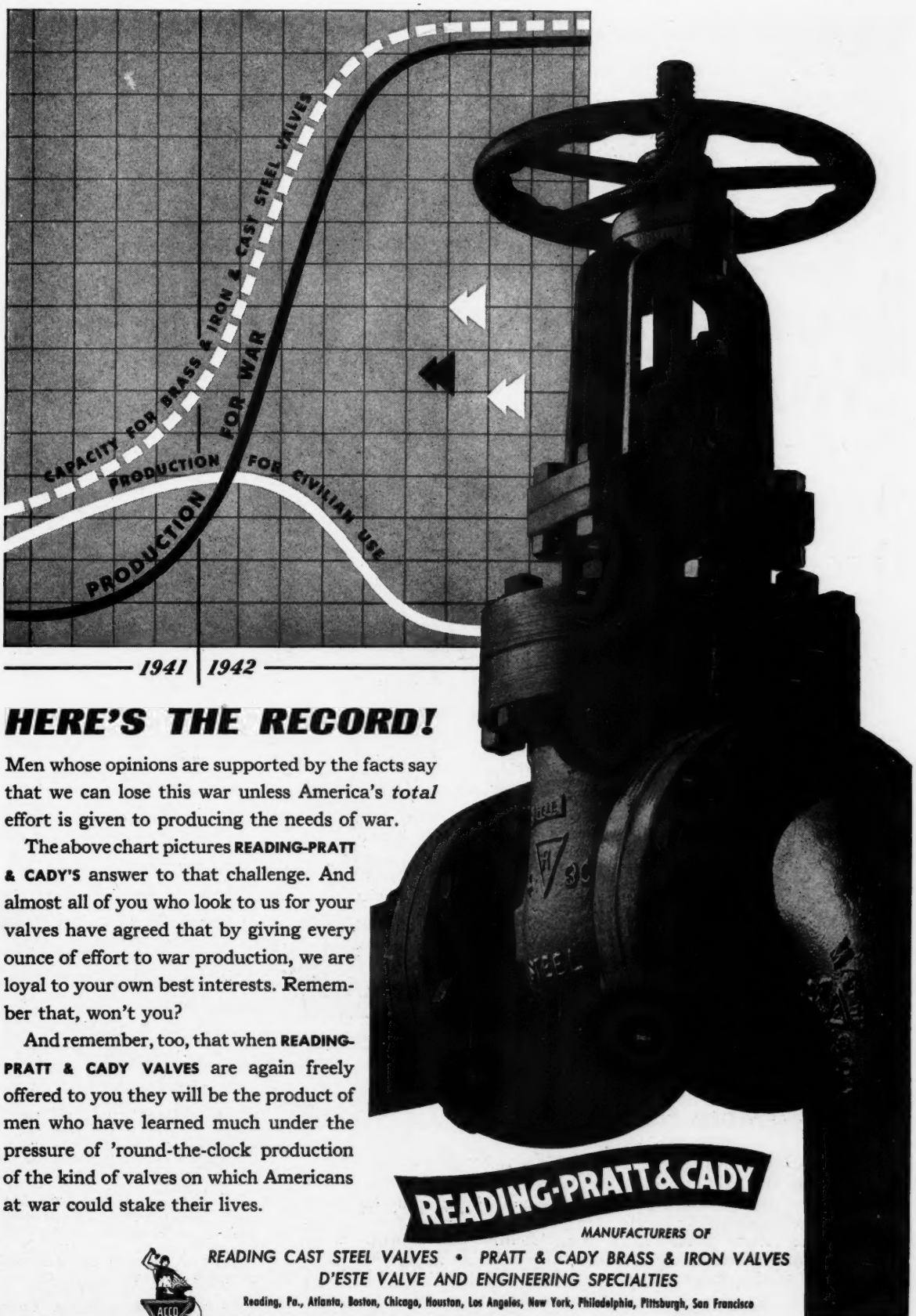
Herbert J. Burgess has been appointed general superintendent in charge of all manufacturing at the Westinghouse Elec. & Mfg. Co.'s East Springfield plant, as announced by W. O. Lippman, works manager. Mr. Burgess had been superintendent of the plant's feeder division since 1937. He joined the company in 1917 and 2 yr. later was promoted to assistant foreman of the toolroom. In 1927 he became supervisor of cost reduction, and in 1935 foreman of tool design and tool manufacturing. In his new assignment he will supervise the plant's five manufacturing divisions.

A. E. Hitchner, former manager of the Los Angeles office of the Westinghouse Elec. & Mfg. Co., has been appointed assistant to the manager of the company's industry sales departments with headquarters at the East Pittsburgh works, as announced by F. H. Stohr, manager.

Joining Westinghouse in 1909 as a salesman, Mr. Hitchner served from 1919 to 1926 as assistant to the manager of the industrial department at East Pittsburgh. In 1926 he was appointed manager of the Los Angeles office and in 1941 commercial assistant to the Pacific Coast District Manager. He received his B.S. degree in electrical engineering at Rutgers College in 1904.

Thomas O. Armstrong, winner of the Westinghouse Order of Merit in 1940, the company's highest employe award, has been named manager of the Westinghouse Elec. & Mfg. Co.'s industrial relations department, East Springfield plant.

Perry R. Cassidy, former executive assistant of The Babcock & Wilcox Co., is now Lt. Colonel in the Engi-



HERE'S THE RECORD!

Men whose opinions are supported by the facts say that we can lose this war unless America's *total* effort is given to producing the needs of war.

The above chart pictures **READING-PRATT & CADY'S** answer to that challenge. And almost all of you who look to us for your valves have agreed that by giving every ounce of effort to war production, we are loyal to your own best interests. Remember that, won't you?

And remember, too, that when **READING-PRATT & CADY VALVES** are again freely offered to you they will be the product of men who have learned much under the pressure of 'round-the-clock production of the kind of valves on which Americans at war could stake their lives.

READING-PRATT & CADY

MANUFACTURERS OF

READING CAST STEEL VALVES • PRATT & CADY BRASS & IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco

A DIVISION OF ACCO **AMERICAN CHAIN & CABLE COMPANY, INC., BRIDGEPORT, CONNECTICUT**

ROTO

Cleans Tubes Thoroughly with *Less Down Time*

Straight tubes, curved tubes, in boilers, superheaters, transfer lines, economizers and condensers—to keep your plant running efficiently you've got to keep them clean.

Roto packs ample power for fast descaling. With the Roto operating air valve the operator himself controls the air supply at the tool, eliminating a helper and saving the time ordinarily wasted signalling between them.

Cut cleaning costs and "down time" to a minimum with Roto Tube Cleaners. Send for details.

The ROTO Company

145 Sussex Ave. Newark, N. J.

More for Your Money

Because advertising is so widely used in the United States, we are the best informed people in the world on what there is to buy, what it will do for us and where to buy it. Because advertising is one of the most economical parts of the selling process and helps identify power plant products of known performance value, it is an important aid in getting more for your money.

neer Corps, U. S. Army. He began his service with Babcock & Wilcox in 1916 and was appointed a vice-president of Fuller Lehigh Co. in 1928. Upon the consolidation of Fuller Lehigh with Babcock & Wilcox he was made an executive assistant of the latter company, holding that position until entering the service.

Charles C. Chamberlain has been named general sales manager of Jenkins Bros., as announced by Farnham Yardley, president of the company. Mr. Chamberlain came to Jenkins Bros. in 1929, on graduation from Hamilton College. Starting as an assistant in the advertising department he was appointed advertising manager in 1932 and has been publicity manager of Jenkins Bros. since 1940. The new general sales manager will make his headquarters at the general offices of the company, 80 White St., New York City.

Louis H. Brendel, manager of Jobber Distribution of Manning, Maxwell & Moore, Inc., has entered the Navy as lieutenant commander in the newly formed Incentive Division.

Russell G. Davis has been elected vice-president of Foote Bros. Gear and Machine Corp., Chicago, Ill. Mr. Davis will continue in his capacity of general manager of the Industrial Gear Division of the company. Other promotions in the sales department of the company are: F. A. Emmons to assistant general manager; R. B. Moir to manager, sales and engineering; W. H. Ostring, special representative; Galen Butterbaugh, speed reducer sales; T. F. Hill, gear sales; and Charles Look, assistant gear sales.

Selden H. Gorham has been appointed manager of dealer sales of Allis-Chalmers Mfg. Co., succeeding Stanley J. Retzlaff who has taken over the trade relations department, as announced by William C. Johnson, general sales manager. Mr. Gorham has been with the company since 1933 and for the past 6 yr. has been in charge of sales and production of the feedwater treating department.

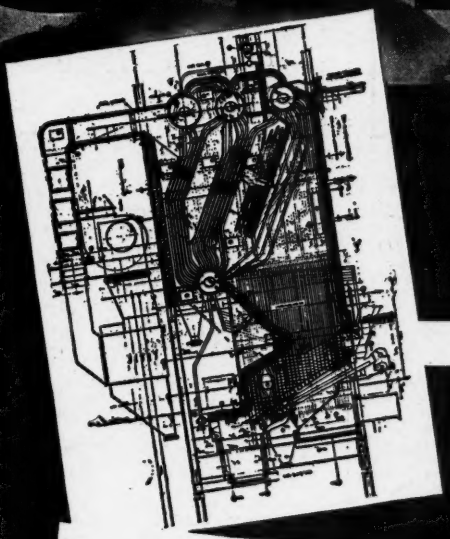
William M. Kennedy recently resigned his position as general manager of Condenser Service & Engineering Co. to become general manager in complete charge of ship construction at the Wainright Yard of the J. A. Jones Construction Co., Panama City, Florida. Mr. Kennedy has been engaged in shipbuilding and ship repairing since 1901 and during World War I served as assistant works manager of the Merchants Shipbuilding Co.'s Bristol yard and works manager of the company's Chester. Pa., yard.

H. L. Watson, since 1934 executive vice-president and director of the De Laval Steam Turbine Co., Trenton, N. J., has been elected president of the company, succeeding Francis J. Arend who died on August 24, 1942. Mr. Watson graduated from Rose Polytechnic Institute in 1905 and entered the employ of the company in 1913.

Robert C. Sessions of the firm of Sessions & Sessions, consulting engineers of Cleveland, Ohio, has been appointed chief engineer of The Brown Fintube Co., Elyria, Ohio. A graduate of Worcester Polytechnic Institute in

STEAM

for



POWER

SOUTHERN COLORADO POWER COMPANY
Pueblo, Colo.

90,000 lbs. steam per hour Vogt LE type bent tube boiler with underfeed stoker. Water walls and economizer. Design pressure 525 lbs. Total steam temperature 750 degrees F.

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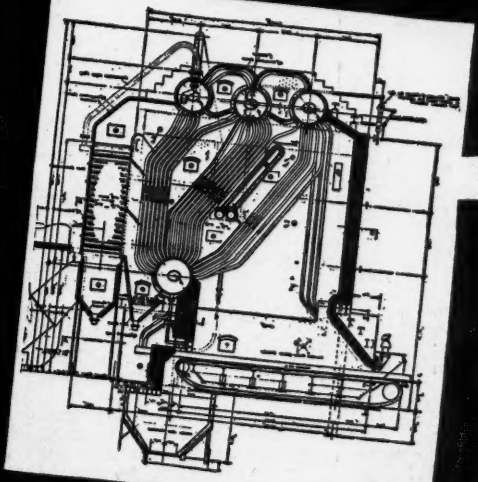

PROCESS

IN A LARGE MID-WESTERN STEEL MILL

Two 105,000 lbs. steam per hour Vogt LE type bent tube boilers with chain grate stokers and economizers. Design pressure 225 lbs. Total steam temperature 550 degrees F.

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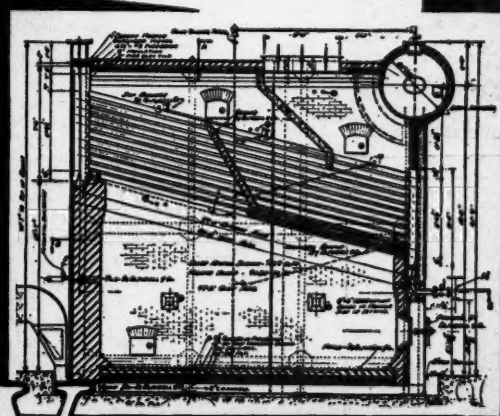


HEATING

CRIMINAL COURTS BUILDING AND JAIL
New York City

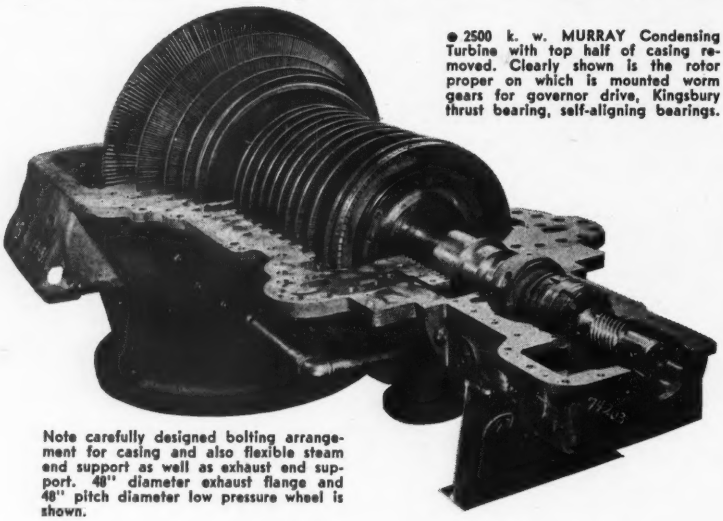
Four Vogt sectional header type boilers of 47,000 lbs. steam per hour capacity, oil fired. Design pressure 200 lbs.

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY
Branch Offices: NEW YORK CLEVELAND CHICAGO PHILADELPHIA DALLAS

Vogt *Water Tube* BOILERS

BENT TUBE AND SECTIONAL HEADER TYPES

We Have *Cooperated* with Industry for over 70 Years on Steam Power Problems



● 2500 k. w. MURRAY Condensing Turbine with top half of casing removed. Clearly shown is the rotor proper on which is mounted worm gears for governor drive, Kingsbury thrust bearing, self-aligning bearings.

Note carefully designed bolting arrangement for casing and also flexible steam end support as well as exhaust end support. 48" diameter exhaust flange and 48" pitch diameter low pressure wheel is shown.

The success of MURRAY Turbines is due to excellence of design, careful selection of materials, and accuracy of workmanship for which this organization has been known for so many years. These turbines continue to be specified by holders of high priorities and our large facilities are busy cooperating in the national victory effort. Those who are not in the high priority purchase group will find it advisable to have full information on MURRAY Turbines so that future needs can be planned. Write for bulletins.

BOILERS TURBINES ENGINES

MURRAY
IRON WORKS COMPANY
INCORPORATED 1870
BURLINGTON IOWA

Looking Ahead...

In the power field, perhaps more than in other basic industrial fields, the continuous betterments in machinery and methods compel men to look ahead with broader vision and greater determination than ever before.

Reading the advertising messages that appear in POWER PLANT ENGINEERING will keep you informed on new trends and opportunities. Month after month, these advertisements describe what's new in generating, transmitting power. They will help you and your plant join the onward march of the power plant industry.

1919, Mr. Sessions was for some time in charge of the engineering and experimental division of Steel & Tubes, Inc., before entering consulting work. The firm of Sessions & Sessions will continue under the direction of Frank L. Sessions, senior partner of the firm.

H. F. Boe Promoted

HARRY F. BOE, manager of Westinghouse Electric & Mfg. Co.'s District Repair & Manufacturing Dept., has been elected vice-president of the company.

Mr. Boe began at Westinghouse in 1901 as a winder of motor armatures in the East Pittsburgh works. After 7 yr. experience in testing electrical equipment he was transferred to the general engineering department and later to the general industrial division as sales engineer. In 1918 he was appointed industrial salesman in the Rochester, N. Y., office and in 1922 became manager of the industrial division of the Buffalo office. In 1927 he was made manager of that office.

In 1935 Mr. Boe was promoted to manager of the company's Eastern Division with headquarters in New York City, later being transferred to Pittsburgh as commercial manager and then becoming manager of the service department, now known as the District Manufacturing and Repair Department. In 1941 he was the recipient of the Westinghouse Order of Merit.

Wilson Appointed WPB Vice-Chairman

CHAIRMAN Donald M. Nelson of the WPB recently announced the appointment of Charles E. Wilson, president of the General Electric Co., as a vice-chairman of the WPB. In this post Mr. Wilson will also serve as chairman of the newly-organized Production Executive Committee, and will exercise the powers of the chairman of the WPB in seeing to it that production programs are met.

Mr. Nelson disclosed that the Production Executive Committee was formed to bring together top officials in the War Production Board, the Army, the Army Air Corps, the Navy and the Maritime Commission to maintain a constant check and control on the production program. This committee will meet twice weekly, under the chairmanship of Mr. Wilson. Its other members will be: Lieut. Gen. Brehon B. Somervell, Commanding General, Services of Supply, U. S. Army; Major Gen. Oliver P. Echols, Commanding General, Materiel Command, Headquarters, Army Air Force; Vice Admiral Samuel M. Robinson, Director of Materiel and Procurement, U. S. Navy; and Rear Admiral Howard L. Vickery, Vice Chairman, U. S. Maritime Commission.

Mr. Wilson has been president of the General Electric Co. since 1940. Born in New York City in 1886, he has been in the electrical industry since 1899, when he went to work with the Sprague Electric Co. in New York. In 1918, when the Sprague Electric Co. was absorbed by General Electric, he became Assistant General Superintendent of the General Electric Works at Maspeth, L. I., and New Kensington, Pa. In 1928 he became assistant to the vice-president, advancing to vice-president in 1930 and to executive vice-president in 1939.

EVERY DIESEL STOPPAGE IS A THREAT TO VICTORY!

Here's how to maintain steady operation with fewer periods of overhaul.

You have higher production quotas to meet —and breakdowns now mean precious man-hours lost.

What's more, with priorities on parts you'll be lucky if you can replace them at all.

Why not let a Cities Service lubrication engineer lend you a hand? His broad maintenance experience—plus special Cities Service instruments available to him—enable him to assist you materially in keeping your engines in continuous operation at top efficiency for long periods.

There is no charge for this friendly consultation. Simply call or write our office nearest you.

You also will be interested in our booklet, "Diesel Lubrication." A copy sent free to the personnel of Diesel oil users. Just clip and mail the coupon below. There is no obligation, of course.

OIL IS AMMUNITION—USE IT WISELY!

CITIES SERVICE OILS
ONCE-ALWAYS

Write to —
CITIES SERVICE OIL COMPANY
Room 1326, Sixty Wall Tower, N. Y.
or any of the following offices:
CHICAGO . CLEVELAND . ST. PAUL
KANSAS CITY . BOSTON . TORONTO
or to
ARKANSAS FUEL OIL COMPANY
SHREVEPORT . ATLANTA . BIRMINGHAM

Please send me your booklet, "Diesel Engine Lubrication." P. P.

Name_____

Firm Name_____

Address_____

City_____ State_____

A LUBRICANT FOR EVERY INDUSTRIAL NEED

Win Today's Battle Against

with

ECLIPSE METAL HOSE

Its deep, parallel sidewall corrugations combine maximum flexibility with lasting toughness—makes Eclipse Seamless Metal Hose the logical low-cost material for Diesel exhausts and for handling all kinds of liquids or gases where vibration and expansion are present.

Eclipse Metal Hose withstands high pressure and temperatures. Monel hose is stocked in sizes ⅛ in. to 2 in. I.D.; steel hose can be produced up to 40 in. I.D. Write us about your problems of conveying non-solids, non-abrasives. Ask for descriptive bulletin.

For

LOW COST LEAKPROOF HANDLING OF

OILS • CHEMICALS • REFRIGERANTS • GASES • AIR • STEAM • VACUUM • HYDRAULIC • Etc.

MANUFACTURED AND SOLD BY

BENDIX AVIATION CORPORATION

Dept. 19 - Phila. Div. PHILADELPHIA, PA.

AN IMPORTANT SERVICE IN THE NATIONAL WAR EFFORT

WE RID YOU OF THIS HAVOC QUARTET
CORROSION
1
Works havoc in your pipes, boilers and heat exchangers
BACTERIAL DEPOSIT
2
Makes itself at home and plugs up your pipes and tubes
HOT WATER SCALE
3
Fights hard to keep you from getting water necessary for production
OILY BOILER DEPOSIT
4
Eats up power and bags your tubes

We conserve metals difficult to replace. We have solved the condensate corrosion problem in steam systems. In the Cook County Nurses' Home in Chicago, where extra heavy wrought iron piping withstood corrosive condensate only thirty days, Haering Glucosates corrected the condition, and test pieces six months later were free from corrosion deposits. We protect metals in boilers, piping, condensers and heat exchangers, too.

The Glucosates also conserve energy. Less fuel is needed—more production obtained—where Glucosates control scale, corrosion and living organisms. The Glucosates save raw materials too. Less chemicals are used where Glucosates substitute for common inorganic materials.

Write today for free booklets of complete story. We will send sample containers and data forms to enable you to give us an accurate picture of your water problems.

Visit the "Chamber of Scale and Corrosion Horrors" in our booth No. 50 at the National Chemical Exposition, Hotel Sherman, Chicago, Nov. 24-29.

D. W. HAERING & CO., INC.

GENERAL OFFICES 205 West Wacker Drive CHICAGO, ILL.

WE READ WATER

Army, Navy Production Awards

The Ambridge Plant of the National Supply Co. received the Army-Navy "E" on Oct. 2 at Ambridge, Pa.

Tube-Turns, Inc., Louisville, Ky., on Sept. 18 awarded the Army-Navy "E" for production accomplishments, has the distinction of being the first war industry plant in the state to be so honored. Army-Navy "E" pins were presented to more than 3000 employes.

Chain Belt Co., Milwaukee, Wis., on Sept. 19 received the Army-Navy Award for excellence in production.

Leeds & Northrup Co., Philadeldelphia, Pa., was presented with the Army-Navy "E" on Sept. 5.

Builders Iron Foundry, Providence, R. I., was recently awarded the Army-Navy Production Award, and its employes were presented with "E" pins.

NEWS FROM THE FIELD

Colonel John Stilwell has recently been elected to serve a 3 yr. term on the Board of Directors of the American Standards Association. He is serving his third term as president of the National Safety Council and has also served as president of the Greater New York Safety Council and of the American Museum of Safety.

Charles G. Maier, noted research metallurgist for nearly 20 yr. associated with the U. S. Bureau of Mines, has been named to the supervisory staff of Battelle Memorial Institute, Columbus, O., one of the country's largest industrial research foundations. According to Clyde E. Williams, Battelle director, Mr. Maier will direct and correlate an enlarged program of fundamental research and will serve as advisor and consultant to the Institute's war research for the government and industry.

Leslie L. Bradley, head mechanic of the Dakota Public Service Co. of Bismarck and frequent contributor to the pages of POWER PLANT ENGINEERING, was recently awarded $100 by the James F. Lincoln Arc Welding Foundation for an essay on the use of arc welding in repairing induced draft fans serving water tube boilers. The essay was submitted in connection with the $200,000 nationwide contest for best papers on welding recently conducted by the Foundation.

A.S.M.E. Elects Officers

HAROLD V. COES, vice-president, Ford, Bacon & Davis, Inc., New York, has been elected president of the American Society of Mechanical Engineers for 1943, according to the official announcement of C. E. Davis, secretary of the society.

Vice-presidents elected at the same

Bartlett·Snow
SKIP HOISTS
—meet every requirement for handling coal, also ashes, limestone and other abrasive materials when the lift is high, capacities large, and a minimum of care and maintenance are desired. Standard and special designs to provide any hourly tonnage capacity. Eng. Bul. No. 83, sent on request, gives full details. The C. O. Bartlett & Snow Co., 6258 Harvard Ave., Cleveland, Ohio.

FIRST AID for WARTIME BEARINGS

Careful use of bearing metals helps the war effort two ways . . . much needed metal is saved . . . and machines stay on the job longer.

- **LINE OLD BRONZE BUSHINGS WITH BABBITT**
- **USE MAGNOLIA'S SUBSTITUTES FOR TIN-BASE BABBITTS**
- **USE THE PROPER METAL FOR EACH BEARING**

Free Bulletin Shows How To Make Better Bearings

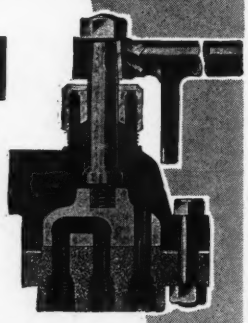
Shows what metal to use where.
Write for this valuable data book.

MAGNOLIA METAL CO.
18 West Jersey Street, Elizabeth, N. J.

MAGNOLIA BEARING METALS

They Stay Tight and Work Right

NICHOLSON
CONTROL VALVES



Give your men and equipment the many advantages of Nicholson 2, 3 and 4-way Valves for controlling steam, air or water cylinders.

These modern control valves stay tight, never stick, improve with use. Non-corrosive metals are used on all vital parts. They are ordered and reordered by engineers for service on pressures up to 300 lb.

The complete Nicholson line also provides foot, solenoid and motor operated control valves; also valves for hydraulic service up to 5000 lb. pressure. Ask for latest illustrated catalog No. 140 on Nicholson Control Valves.

Other Nicholson Products:
Industrial Steam Traps
●
Welded Floats
●
Flexible Couplings
●
Steam Eliminators and Separators
●
Compressed Air Traps

W. H. NICHOLSON & CO.
160 Oregon St. Wilkes-Barre, Pa.

time to serve 2-yr. terms on the Council of the A.S.M.E. were Joseph W. Eshelman, president, Eshelman & Potter, Birmingham, Ala.; Thomas E. Purcell, general superintendent of power stations of the Duquesne Light Co., Pittsburgh, Pa.; Guy T. Shoemaker, vice-president, Kansas City Light & Power Co., Kansas City, Mo.; and Walter J. Wohlenberg, professor of mechanical engineering, Yale University, New Haven, Conn.

Managers of the Society elected to serve on Council for 3-yr. terms include Roscoe W. Morton, professor of mechanical engineering and head of the department, University of Tennessee, Knoxville, Tenn.; Alexander R. Stevenson, Jr., staff assistant to vice-president, General Electric Co., Schenectady, N. Y.; and Albert E. White, director engineering research, University of Michigan, Ann Arbor, Mich.

The new officers will be installed during the 63rd Annual Meeting of the Society to be held in New York, N. Y., at the Hotel Astor, November 30-December 4, 1942.

Air-Cargo Meeting in Chicago

ENGINEERING problems which must precede large-scale development of wartime military transportations, supplies and personnel as well as peacetime movement of express and freight cargoes by airplane will be considered at an Air-Cargo Engineering Meeting sponsored by the Society of Automotive Engineers and scheduled to be held in the Knickerbocker Hotel, Chicago, Ill., on December 8 and 9. The tentative program calls for discussion of engineering problems related to current experience in converting passenger planes into cargo carriers, design and construction of future air-freighters, the possible utilization of cargo-carrier gliders and engineering factors involved in adapting airport facilities and personnel to wartime demands. J. Howard Pile, editorial director of Chek-Chart Corp., Chicago, is chairman of the Chicago Section of the S.A.E.

Power Show Opens in New York Nov. 30

THE 15th National Exposition of Power & Mechanical Engineering will be held Nov. 30 to Dec. 4 in the Exposition Hall of Madison Square Garden, New York, N. Y.

This year the Exposition has been organized for the special purpose of contributing to the Nation's war effort by concentrating at one time and place equipment, information and the mental resources needed to maintain, increase and use more efficiently the country's power production.

The scope of the undertaking is shown by an analysis of the last Power Show held in 1940. There was a total attendance of 34,087 at this show by invitation and registration only. This represented nearly 60 industries and professions. About 8000 of this attendance were engineers, civil, mechanical, mining and metallurgical, as well as chemists, research directors and physicists.

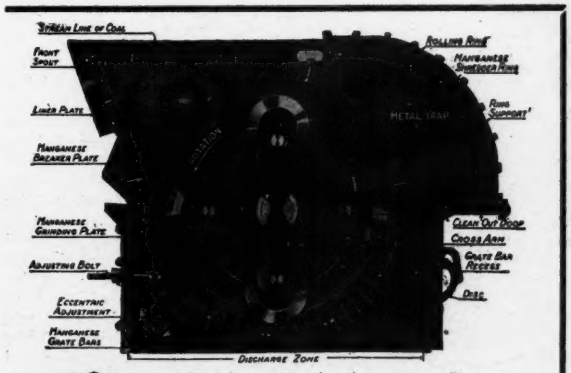
Approaching this year's Exposition, the management conducted a survey of those registered at the 1940 Power Show. This survey showed that more than 60 per cent of those planning to attend this year's show were interested primarily in

COAL IS AMMUNITION FOR WARTIME PRODUCTION — USE IT WISELY

SIZE IT FOR SAVINGS

The "AMERICAN" CRUSHER WAY

ONE of the many progressive stations taking advantage of better coal sizing to improve boiler performance and effect worth-while savings is the plant of the Central Illinois Light Co., Peoria, Ill., as illustrated at the right.



Above: Cross-sectional view of American Ring Crusher. Left: Patent shredder rings split coal in uniform size instead of crushing it —a patented "American" feature.

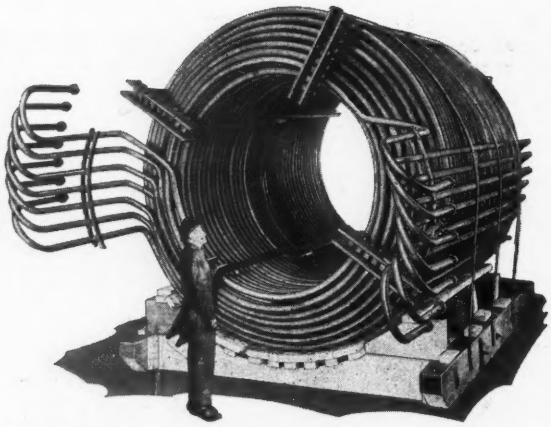
Here, a Type S AMERICAN RING CRUSHER reduces coal from run of mine to screenings—properly sizes it at the rate of 125 tons per hour, eight hours per day.

In many plants, large and small, fuel savings from 2½ to 8 per cent are being reported and total crushing costs (including fixed charges) kept to less than 2 cents a ton through the installation of "AMERICANS."

You, too, have a splendid opportunity to step up boiler performance and step down costs through better coal sizing the AMERICAN Crusher Way. Complete crusher information, including names and addresses of users, will be forwarded on request.

AMERICAN PULVERIZER COMPANY 1429 Macklind Avenue St. Louis, Missouri

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS



To Aid War Production—

A 1¾ MILE NESTED SPIRAL COIL

Typical of the way in which Rempe engineering and production facilities are contributing to the war effort is this giant multiple spiral coil recently delivered to a machinery fabrication plant.

Built of Grade A-106 seamless steel pipe, with seven separate circuits, this large heating coil contains more than 1¾ miles of pipe and weighs 22,000 lb.

Rempe Coils and Bends are made from any material to customer's specifications —are widely favored by engineers for Heat Exchangers, Feed Water Heaters, Coils for Refrigeration Machines, Chemical Processes, etc. Write for estimates.

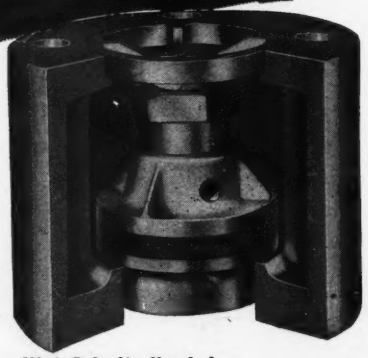
REMPE CO.

342 No. Sacramento Blvd., Chicago

JOIN THE "Anti-Noise" CAMPAIGN...

Use COMBINATION SILENT CHECK VALVES

Ends "Water Hammer" on Boiler Feed Lines, Foot Valves, House Pumps, Liquid and Steam Lines.



Your first step in assuring smoother, quieter, more efficient pump discharge, is the installation of Combination SILENT CHECK VALVES.

Note these important money-saving features: 1. Spring-Loaded—when flow ceases, valve is closed without chance of water hammer; 2. Area through valve is 20% in excess of pipe area; 3. Really silent in operation; 4. All valve wear is on easily replaced or repaired parts; 5. Works equally well on Boiler Feed Lines, House Pumps, Liquid and Steam Lines; also used as Foot Valves.

Write today for descriptive bulletin giving pressure ranges, dimensions, prices and other helpful data on SILENT CHECK VALVES.

High Priority Needed: The use of critical materials in producing Combination SILENT CHECK VALVES makes it necessary for buyers to furnish a high priority. Your cooperation in furnishing complete priority data with each order will aid us in expediting shipments and in better serving the nation's war effort.

COMBINATION PUMP VALVE CO.

846 WIOTA STREET, PHILADELPHIA, PA.

power plant equipment, including generation, distribution and control apparatus. An increasing amount of interest was expressed in power utilization, transmission equipment, material handling, electrical equipment, such as motor drives and controls, tools and machine tools, metals, plastics and substitutes and metal working in the way of welding, soldering and brazing.

The war production theme will be carried throughout the show with special attention directed to substitute materials and to the necessity of improving efficiency of the plant rather than expansion to meet the increased power demands. Where new equipment is difficult to obtain, power users are leaving no stones unturned in stepping up output by overhauling, improvements and the addition of all manner of auxiliary appliances of the many kinds which the Exposition has brought forth in the past. Problems in the redistribution of power have been brought about by the conversion of many plants to war work, including changes in plant arrangement and the installation of new machinery.

Exhibitors who have enrolled for the Exposition include manufacturers of practically every kind of equipment used in power plants and in the application of power to machinery, as well as water, steam and air to processing equipment. Products exhibited are classified under the following headings: Heat and power production; distribution and control; auxiliaries; instruments; transmission apparatus; materials handling; metals; engineering specialties; machines and tools.

Admission is by invitation and registration only. No admission fee is charged. The public is not admitted, but registrations are accepted from all persons interested in mechanical plants.

The National Exposition of Power and Mechanical Engineering is under the management of the International Exposition Company, Grand Central Palace, New York, and Charles F. Roth is manager.

Lincoln Welding Foundation Awards

THE James F. Lincoln Arc Welding Foundation announces the winners in its second industrial study on arc welding. First prize of $2500 was awarded to George F. Wolfe, chief plant engineer, of the Dravo Corp. for his paper on large sections of hulls prefabricated by welding. Second prize of $1700 was awarded to C. Perry Streithof, structural division engineer, Dravo Corp., for his paper on revolving gantry crane for shipbuilding; and third prize of $250 to R. M. Rush, Manager, and H. A. Pietsch, Industrial Machinery Division, Dravo Corp., for their paper on the design and development of a direct fired unit heater for oil, gas, and coal firing.

The Foundation has been carrying on this second industrial study on arc welding for 2½ yr. and made 408 awards totaling $200,000. Results of the study show that the war industries have only begun to gain the benefits of modern arc welding and that further application of the welding process will slash hundreds of millions of dollars off the United Nations' war bill and will cut the time required to produce ships and planes by 30 per cent.

Papers were submitted from engi-

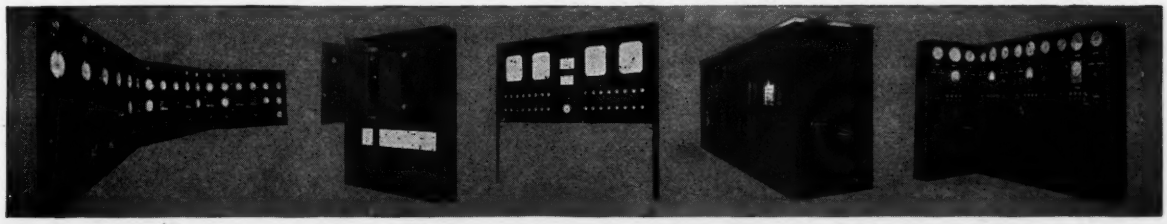
STEEL PANELS BY FALSTROM

THE construction of steel panels for an instrument board as large as this impressive installation certainly is a job for experts. Experts to design the system . . . to appoint the contractor . . . to select instruments and controls . . . and finally, experts to build the steel panels.

Falstrom has been awarded thousands of panel jobs, large and small, because of its reputation of service in this field . . . a service which includes proper interpretation of customers drawings . . . recommendations for better or less expensive fabricating methods . . . precise manufacture . . . faultless surface finish . . . and, now very important, reasonable deliveries.

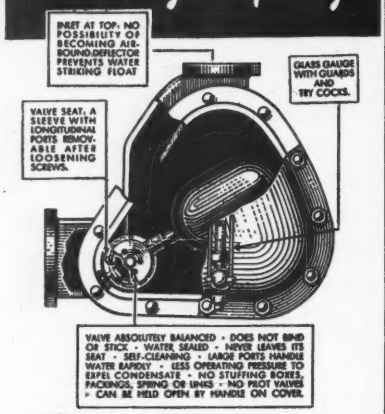
For emergency defense construction, more now than ever, you must be sure to build right and to build fast. Falstrom can help you meet those delivery dates on all types of steel switchgear mounting or enclosing structures as well as other fabricated steel parts. For quotations, send your blueprints. Write for free catalogs to Falstrom Company, 77 Falstrom Court, Passaic, New Jersey.

STEEL INSTRUMENT PANELS—CUBICLES—CABINETS—SWITCHGEAR ENCLOSURES FOR EVERY INSTALLATION NEED.



FALSTROM

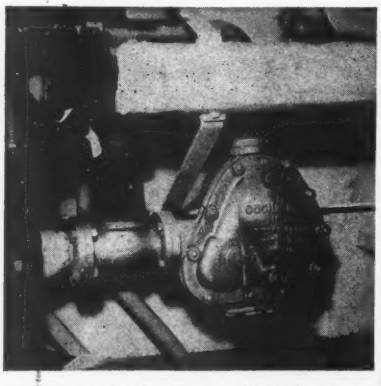
Extraordinary Discharge Capacity


FAST AT TOP: NO POSSIBILITY OF BECOMING AIR-BOUND-DEFLECTOR PREVENTS WATER STRIKING FLOAT
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE SEAT: A SLEEVE WITH LONGITUDINAL PORTS REMOVABLE AFTER LOOSENING SCREWS.
VALVE ABSOLUTELY BALANCED • DOES NOT BIND OR STICK • WATER SEALED • NEVER LEAVES ITS SEAT • SELF-CLEANING • LARGE PORTS HANDLE WATER RAPIDLY • LESS OPERATING PRESSURE TO EXPEL CONDENSATE • NO STUFFING BOXES, PACKINGS, SPRING OR LINKS • NO PILOT VALVES • CAN BE HELD OPEN BY HANDLE ON COVER.

Cochrane

MULTIPORT DRAINER

for Quick Drainage of Large Quantities of Condensate . . .



THE "Multiport" principle on which the Cochrane Drainer operates is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacities of these ports is unusually large, which accounts for the valve's extraordinary discharge capacity. For complete details mail this coupon.

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neers, designers, architects, maintenance men and executives from 46 of the 48 states. There were 458 recipients of the 408 awards, the difference covering joint authorship of some of the papers. The great mass of important new welding data contained in these papers will soon be made available for the benefit of war industries, first in the form of articles in trade publications and other magazines and later in book form. This same procedure was followed after the study made by the Foundation in 1937-38 which resulted in the dissemination of information of vital importance in the nation's war production utilizing welding.

National Chemical Exposition in Chicago

REPLETE with innovations and stressing the importance of the industry in the effective prosecution of the war, the National Chemical Exposition to be held November 24 to 29 in the Hotel Sherman in Chicago, Ill., will focus the attention of the chemical world on the midwest metropolis during that period.

Outstanding features will be the first symposium of Electron Microscopists in which more than 200 are expected to take part and an exhibit by the Industrial Salvage Section, Conservation Division of the War Production Board to further its campaign to salvage approximately 100,000,000 lb. of essential chemicals.

The exposition and National Industrial Chemical Conference to be held in conjunction will be the second sponsored by the Chicago Section of the American Chemical Society. The first, held in December, 1940, attracted more than 25,000 visitors.

Percy Nicholls Award to E. G. Bailey

AT THE banquet of the joint Fuels Conference of the Coal Division, A.I.M.E., and Fuels Division, A.S.M.E., in St. Louis, Mo., Sept. 30, Eugene McAuliffe, president, A.I.M.E., presented E. G. Bailey, vice-president, Babcock and Wilcox Co., New York, the first Percy Nicholls Award, "for notable scientific or industrial achievement in the field of solid fuels".

Following his acknowledgment of the award, Mr. Bailey discussed the present fuel emergency and the steps now being taken to meet it, and suggested preparation for what may be a more acute fuel situation than any yet contemplated.

"I am fearful", said Mr. Bailey, "we have been soft in our ways of looking at many of our day-to-day problems, not realizing what the problems of tomorrow might be. Those engaged in the coal industry in the past and possibly at present have been responsible for this condition, at least in some considerable measure, through their lack of foresight, as to what was good for the users of fuel, as well as for their industry.

"While there are shortages of many materials and equipment needed for the conventional methods of conversion from oil to coal, there should be no shortage of brains and applied effort on the part of those who have spent years studying combustion and the uses of coal and looking for the place and opportunity to use their knowledge. It takes very little critical material for full-sized

HENSZEY BOILER FEED WATER METERS

Henszey Meters accurately measure boiler feed water, hot dirty blowdown, condensate, free running chemicals, and many other liquids that cannot be satisfactorily measured by ordinary meters. They are equally accurate at high or low flow, high or low pressure, on reciprocating, duplex, triplex or centrifugal pumps. Sizes range from 10 g.p.m. to 1200 g.p.m. cold water steady flow rating. Pipe connections ¾" to 6". Calibrations can be made to read in gallons, pounds, or cubic feet at any specified temperature. The meter is easily installed right in the line.

Check your meter requirements today. Send for complete information stating your specific problem if possible. No obligation for unbiased recommendations.

HENSZEY COMPANY
Dept. C11, Watertown, Wis.

HENSZEY

TO INSURE AGAINST SPONTANEOUS FIRING

. . . store your coal the SAUERMAN way

A cross-section of a storage pile properly built by a Sauerman Scraper shows the coal in tightly packed layers with air pockets entirely absent. There is no chance for heat to generate within the pile.

Along with this feature of safety, a Sauerman installation offers such other advantages as: low first cost, economical upkeep, simplicity of operation.

WRITE FOR CATALOG

SAUERMAN BROS., Inc.
586 S. Clinton St., CHICAGO

TO EXECUTIVES:

NOW YOU CAN HELP

Even More...

New Treasury Ruling Permits Purchases UP TO $100,000, in any Calendar Year, of Series F and G WAR BONDS!

The Treasury's decision to increase the limitations on the F and G Bonds resulted from numerous requests by purchasers who asked the opportunity to put more money into the war program.

This is not a new Bond issue and not a new series of War Bonds. Thousands of individuals, corporations, labor unions, and other organizations have this year already purchased $50,000 of Series F and G Bonds, the old limit. Under the new regulations, however, these Bond holders will be permitted to make additional purchases of $50,000 in the remaining months of the year. The new limitation on holdings of $100,000 in any one calendar year in either Series F or G, or in both series combined, is on the cost price, not on the maturity value.

Series F and G Bonds are intended primarily for larger investors and may be registered in the names of fiduciaries, corporations, labor unions and other groups, as well as in the names of individuals.

The Series F Bond is a 12-year appreciation Bond, issued on a discount basis at 74 percent of maturity value. If held to maturity, 12 years from the date of issue, the Bond draws interest equivalent to 2.53 percent a year; computed on the purchase price, compounded semiannually.

The Series G Bond is a 12-year current income Bond issued at par, and draws interest of 2.5 percent a year, paid semiannually by Treasury check.

Don't delay—your "fighting dollars" are needed *now*. Your bank or post office has full details.

Save With . . .

War Savings Bonds

This space is a contribution to America's All-Out War Program by POWER PLANT ENGINEERING

Need MORE STEAM in a hurry?

install Enco Streamlined BAFFLES

YOU can get increased steam capacity at once—without waiting months for a new boiler—by installing Enco Streamlined Baffles in your existing boilers.

Enco Streamlined Baffles recently installed in four bent tube boilers increased their total steam output by 50%, and in an emergency test, the full load was carried with two instead of four boilers.

The streamline principle obtains the best results from the heating surface available in each boiler, reduces draft drop, eliminates eddy currents and dead gas pockets that collect soot and fly ash.

Correctly designed for either horizontal or vertical bent tube boilers, Enco Streamlined Baffles are installed by skilled mechanics with materials proved by years of experience to be best for the purpose.

Write for Bulletin BW-40, or save time by sending Blue print and operating data.

THE ENGINEER CO.
Enco 75 West St. New York, N. Y.

working experiments, and our Government has been helpful in permitting and, if need be, in promoting projects of merit when properly planned.

"Coal producers should maintain quality fuel for maximum economy, considering cost of production, freight and handling; and their agents should see that fuel is distributed to users where it is best fitted to their handling and burning equipment.

"Every one responsible for the storage, handling and burning of any fuel should be alert and diligent in obtaining the required output at the maximum obtainable efficiency.

"Cleanliness, both as to coal dust and smoke should be exercised now more than ever. It is economical, it is foresighted to keep as clean as possible with coal.

"Most important of all is to have enough good coal available at every place of use when needed, so that our railroads will not falter nor any defense plant slow down for lack of power. So far you have done a good job, let us not stop to boast—let us do it still better."

NEW ENGINEERING BOOKS

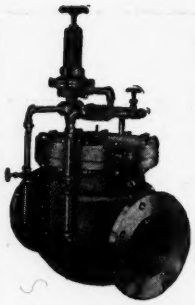
How the Priority System Works. 6 by 9 in. Pamphlet form. Paper Cover. Research Institute of America, Inc., 292 Madison Ave., New York, N. Y. Price $2.00.

The system is first described, then the methods of establishing controls, how ratings are secured, requirements for purchasing with production requirements, distributors' ratings and accounting required. Detailed suggestions are given as to securing and improving priority ratings, also reports to be made to retain ratings. Instruction is clear as to preparing a letter of transmittal and the information that should be given to establish claim for priority. The Institute has produced a helpful manual with many suggestions and recommendations as to proper courses of procedure.

The Marine Power Plant. By Lawrence B. Chapman. Copyright 1942. Second edition (completely rewritten), size 6 by 9 in., 394 pp., cloth bound. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price $4.00.

Improvements in economy and changes in marine engineering during the last 20 yr. have necessitated a complete rewriting of this book, although the plan and purpose of the first edition have been adhered to. It is intended as an elementary book in marine engineering, stresses fundamental principles and thermodynamics with only sufficient descriptive material and detail to make clear the principles involved.

It is written from the view point of the seagoing engineer and shore operating staff. New types of marine machinery are covered and although the



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Sizes: 3" to 36" Angle and Globe Patterns

On excess pressure, due to line surges or excess pumping head, this valve automatically opens to dissipate necessary water volume to maintain desired line pressure. The valve is arranged either with atmospheric pilot valve exhaust or self-contained, according to service conditions and requirements.

Valves may be arranged to open at abnormal pressures and held open under subnormal pressures until the surge subsides, and then close when normal conditions prevail.

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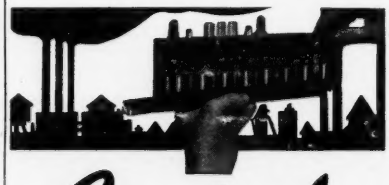

Control OF BOILER WATER IS EASY AND FAST WITH A TAYLOR COMPARATOR

Keep your steam generating equipment in constant top-notch condition, assure economical, high-efficiency operation and eliminate time-wasting, costly descaling jobs by using the Taylor Boiler Water Comparator. Determines the pH and phosphate content of your boiler water in less than 2 minutes. Absolutely accurate—thousands in daily use attest its need in the modern boiler room. All Taylor Color Standards carry an UNLIMITED GUARANTEE AGAINST FADING!

See your dealer . . . or write direct for free booklet, "Modern pH and Chlorine Control".

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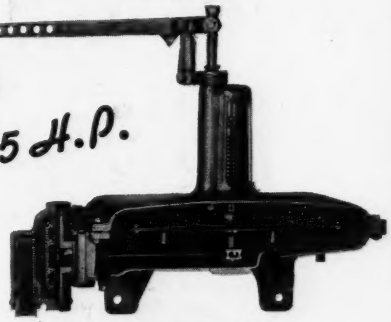
Stretch YOUR FUEL TO ITS GREATEST PRODUCTIVE VALUE . . .

YOU can achieve quick and continuous fuel savings by making your coal, oil, or gas (whichever you burn) give you the most in results. You can make your boiler room become a greater factor in production as you keep fuel consumption low. This is all accomplished by furnace draft control, air flow control, and fuel feed control. Each of these units is described below.

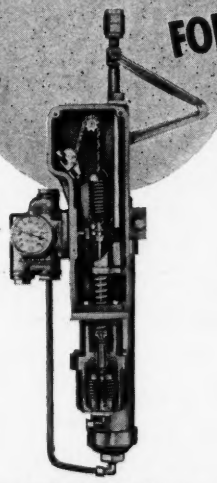
Hooked up together in an automatic system these CASH STANDARD units meter the fuel supply, continually adjust air supply as required, and operate the stack damper — to make your boiler room produce more steam with less fuel — to help you conserve manpower by cutting attendance time — to eliminate much waste.

CASH STANDARD AUTOMATIC COMBUSTION CONTROL SYSTEMS FOR ALL TYPES OF PLANTS *Small as 75 H.P.*



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



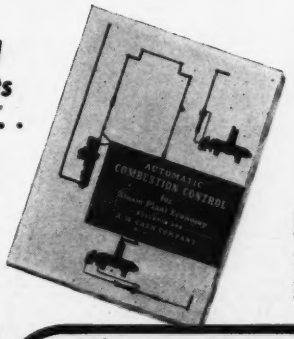
FUEL FEED CONTROLLER

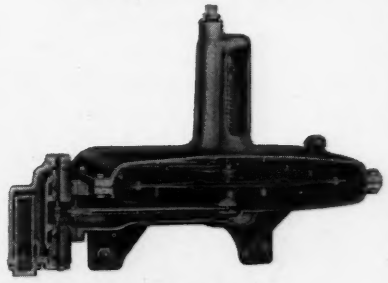
This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

CORRECT FUEL FEED
You Save COAL, OIL OR GAS
PROPER AIR SUPPLY
YOU BURN FUEL *Economically*
CONSTANT OVER-FIRE DRAFT
You Prevent UNDUE STACK LOSS

Bulletin Gives You Full Details on These Points
SEND FOR IT . . . .

Bulletin No. 300 gives full details on Automatic Combustion Control for steam plant economy and shows applications of these systems for those who burn coal, oil or gas.





FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.

A. W. CASH COMPANY
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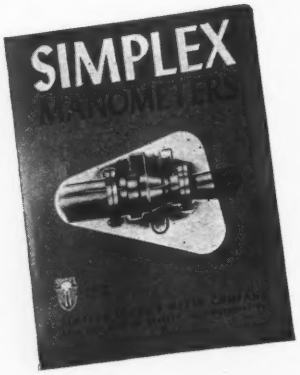
CASH STANDARD
CONTROLS . . VALVES

EASY TO USE MANOMETER DATA

Contained in the new Simplex Bulletin No. 200 is information for the user of manometers. It covers the complete line of Simplex manometers and accessories, and details in concise, usable form, basic data and formulae applying to the use and application of this equipment.



Simplex Valve & Meter Company has long experience in the manufacture of manometers for a wide variety of uses in the water, power and process industries, including the type MAC—the portable manometer—a field laboratory in a handy carrying case.

Write today for your copy of Simplex Bulletin 200 — a reference booklet that is file-worthy.

SIMPLEX METERS

SIMPLEX VALVE & METER CO.
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book deals largely with American practice, frequent reference is made to the marine power plants of other countries. Special attention has been given to fuel oils, combustion, geared turbines and feedwater systems.

It is divided into 13 chapters covering fuels, marine boilers, combustion, reciprocating steam engines, turbines, electric drive, Diesel engines, comparison of types of propelling machinery, condenser and condenser auxiliaries, feedwater heating and feedwater systems, power plant layouts and computations for the marine power plant.

The author is Professor of Marine Transportation and Marine Engineering at Massachusetts Institute of Technology and the book is dedicated to his son, Charles Edmund Chapman, Ensign, U.S.N.R.

Aircraft Engine Design. By Joseph Liston. Copyright 1942. Size 6½ by 9¼ in., 486 pp., cloth bound. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Price $4.50.

Students entering this field of study are usually totally lacking the essential experience in deciding a logical order of procedure of engine design, so the purpose of this book is to aid these technical students in bridging the gap between the point where they have a fairly complete knowledge of the fundamentals of mathematics, mechanics and machine design and the point where they are sufficiently familiar with the application of these fundamentals to the design of aircraft engines to enable them to be of value to the aircraft-engine building industry.

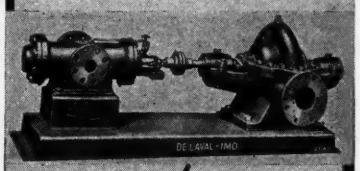
The book attempts to encourage students to select a conventional type of engine for their first design and suggests the use of new ideas and possible improvements over the conventional engines, and, bases the belief founded largely on teaching experience, that students cannot very well design an improved or unconventional engine until they are familiar with the shortcomings and weaknesses of conventional engines.

Chapters in the content deal with gas pressure forces; analysis of the crank chain and bearing loads; design of reciprocating parts; vibration, balance, reduction gearing and details of the crankshaft; cylinders and valves; the valve gear; the crankcase, superchargers, and accessories. The appendix includes: technical data on aircraft engines and engine parts; properties of aircraft-engine materials; and useful design formulas.

STATEMENT of the ownership management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of POWER PLANT ENGINEERING, published monthly at Chicago, Illinois, for October 1, 1942.
State of Illinois, } ss.
County of Cook, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kingsley L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the cir-

NO SPEED LIMIT



IMO I MOVE OIL

for IMO

The DE LAVAL-IMO rotary displacement OIL PUMP operates at standard motor or turbine speeds. The pump here shown is driven by a high-speed water turbine. The three moving parts of an IMO pump are in perfect rotational balance. There are no valves and no gears and there is only one stuffing box, which is subject to suction pressure only. Any kind of oil is pumped in any volume and against any pressure.

Ask for Publication 1-98.

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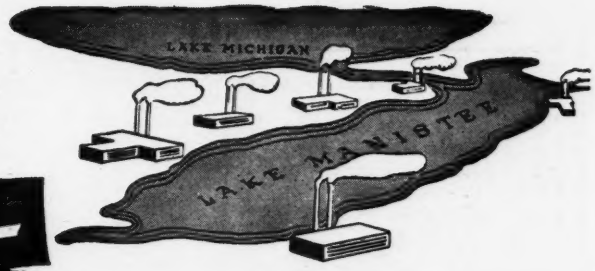
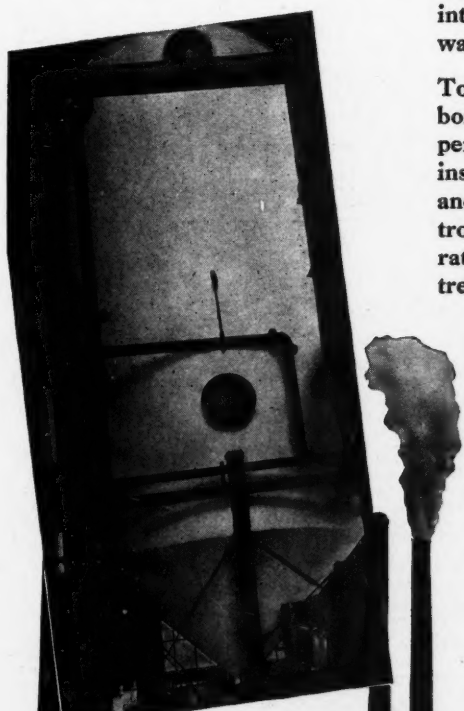


Every time the Wind Changes—

a different raw water to treat

The plant of the Filer Fibre Company at Filer City, Michigan, depends upon Lake Manistee for its raw water supply. Six industrial plants empty various kinds of industrial waste into this lake with the result that there is a different water condition to meet every time the wind changes direction.



To meet these varying conditions and provide properly treated boiler feed water for the production of 3,350,000 lbs. of steam per day, a Graver Hot Process Water Softening System was installed, including preheaters, settling tanks, mixing tanks, and pressure filters. A Graver Chemical Proportioner controls the flow of chemicals into the softener tank in exact ratio to the volume of raw water being treated. Tests of the treated water are made every two hours and the proportions of chemicals used in the mix can be changed instantly to meet any variation shown by these tests.

After 16 months of operation, Filer Fibre Co. reports as follows: *"Besides improving operating efficiency and providing better average water conditions in our boilers, this system has reduced chemical costs by more than* 50%."

This story is typical of hundreds of water conditioning problems solved by Graver during the past 30 years. Remember, Graver designs, builds, and installs water conditioning equipment *of all types* to meet your individual needs. Let us tell you more about our complete service. Write to Graver Tank & Mfg. Co., Inc., 4809-8 Tod Avenue, East Chicago, Indiana.

GRAVER *Water Conditioning Equipment*

42-44-W

"Every dime and dollar not vitally needed for absolute necessities should go into WAR BONDS and STAMPS to add to the striking power of our armed forces."
—*President Roosevelt*

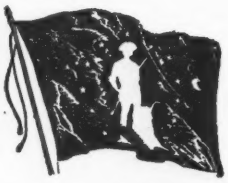
EVERYBODY EVERY PAYDAY 10%

IN WAR BONDS

* * * * * * * * *

New Goal for Payroll Savings Plan!

Along with increased war production goals go increased costs . . . extra billions which must be raised, and raised fast, to win this war. That means we must raise our sights all along the line, with every firm offering every American with a regular income the chance to buy more *War Bonds*. YOUR help is asked in encouraging employees to put at least 10 percent of their pay into War Bonds every payday, through the Payroll Savings Plan. For details of the Plan, approved by organized labor, write, wire, or phone Treasury Department, Section T, 709 12th St. N. W., Washington, D. C.



U.S. WAR SAVINGS BONDS

This space contributed to America's All-Out War Program by
POWER PLANT ENGINEERING

culation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Publishing Company, Chicago, Ill.

Editor, R. E. Turner, Chicago, Ill.

Managing Editor, None.

Business Manager, Kingsley L. Rice, Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

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4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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JOHN O. AARVOLD.

(My commission expires March 20, 1944.)

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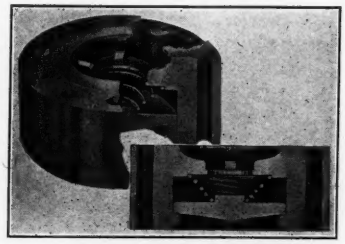

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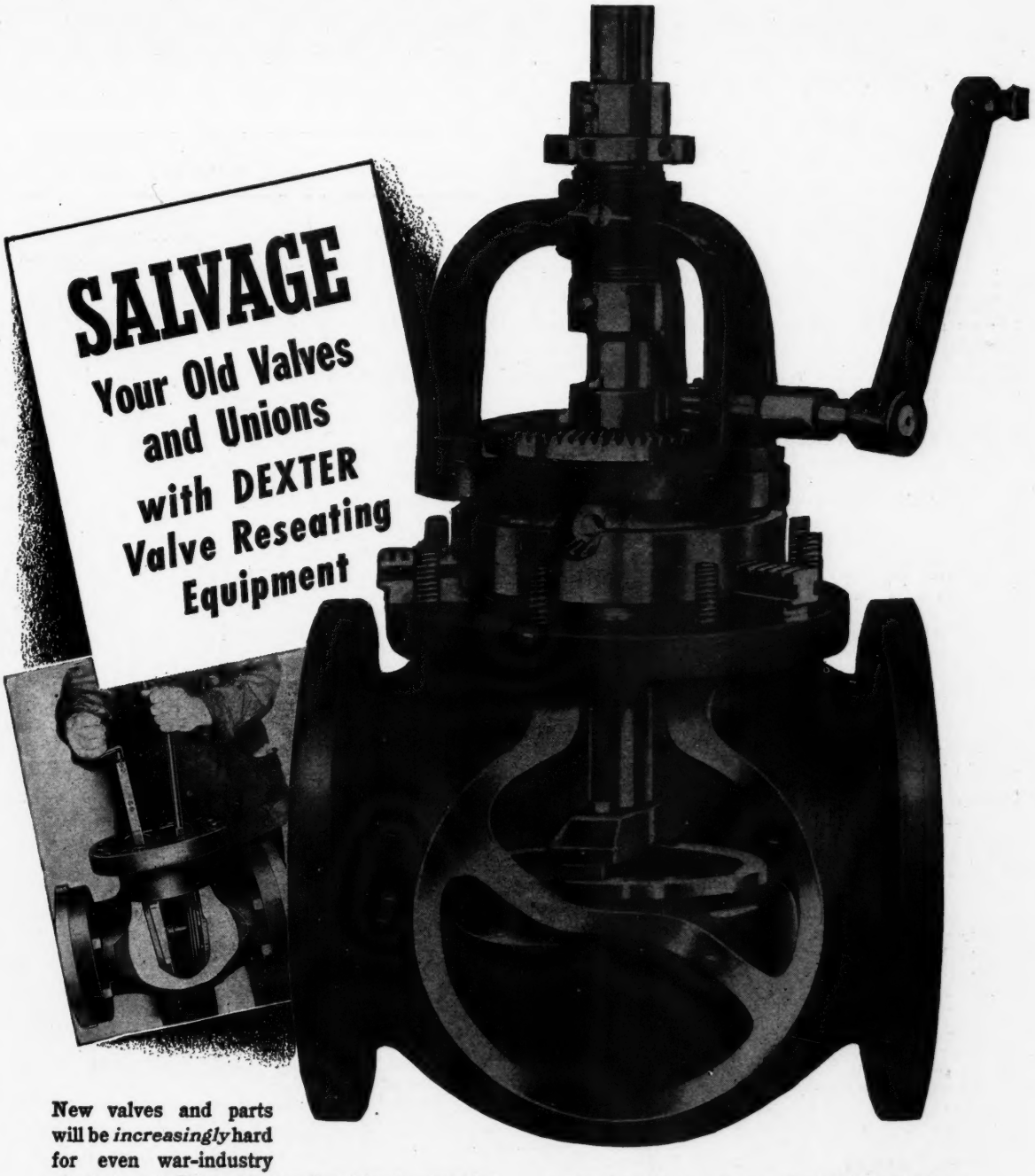

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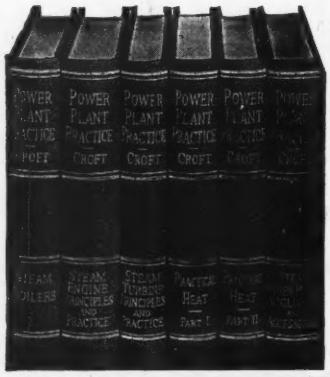

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FOR THE ENGINEER'S LIBRARY

Coupon for obtaining free literature listed here may be found on page 166, under the heading Helpful Bulletins.

Instruments and Controls

1 **Speed Indicator**—Bulletin 715 illustrates and describes model DS chronometric Tachometer or Speed Indicator for measuring r.p.m. and f.p.m. Catalog 2302 covers speeds ranging from 0-2000 r.p.m. and Catalog 2301 covers speeds ranging from 0-20,000 r.p.m. Herman H. Sticht Co., Inc.

2 **Electric Draft Gage**—The Barolectric, an electric indicating and actuating draft gage, is described in 4-p. Form BED-413. Included are construction features and sizes. Data on barometric dry controls for oil and stoker firing is included with information on various other manual and automatic draft gages. Combustion Equipment Division, The Hotstream Heater Co.

3 **Draft Gages**—Draft and air pressure gages are illustrated and described in Form 5-BED-411. Applicable to oil, stoker and hand firing operation, the gage operates with a dry diaphragm and without springs or electric bells. Also included is information on the Fyrite CO_2 indicator. Combustion Equipment Division, The Hotstream Heater Co.

4 **Flue Gas Gage**—Form 5-TG-4110 describes the Hotstream Thermogage, an electric thermo-couple flue gas temperature indicator. Included are advantages, operation and construction features and price. The Hotstream Heater Co.

5 **Combustion Control Equipment**—4-p. Form HCC-4112 describes various combustion and modulating controls and damper regulators. Application, construction and operation details are included. Combustion Equipment Division, The Hotstream Heater Co.

Electrical Equipment

6 **Discharge Counter**—Discharge counter for use with lightning arresters is described in 4-p. Bulletin GEA-3864. Operation principle, design, construction and installations are included together with illustrations. General Electric Co.

7 **Motors**—Bulletin B6052-C, designed to give all the facts necessary for choosing correct motors quickly for wartime applications, includes simplified charts for determining at a glance all electrical and mechanical characteristics of the motor types designed for desired applications. In addition, construction features of various Lo-Maintenance motors are completely described and numerous typical applications are illustrated. Allis-Chalmers Mfg. Co.

8 **Bus Protection**—Linear coupler bus protection which meets three major power system requirements is described in 28-p. Booklet B-3137. Information on the bus protection which minimizes major station damage, localizes power outages due to bus failures, protects the benefits of system interconnection, is detailed. Westinghouse Elec. & Mfg. Co.

9 **Electronic Tubes**—A quick-selection and comprehensive chart of electronic tubes for industry, with technical data on applications and tubes, has been recently released. General Electric Radio, Television and Electronics Dept., General Electric Co.

10 **Switchgear**—Metal-enclosed switchgear for heavy-duty d.c. service up to 250 v., 8000 amp. is described in 12-p. Bulletin GEA-3850. The switchgear which has all-round accessibility at the front and rear also is said to have disconnecting switches that are made to withstand short circuits of more than 150,000 amp. General Electric Co.

11 **Portable Watthour Meter**—An 8-p. Catalog GEA-3614 describes the new light weight 1B-10 portable watthour meter standard which has high and low current capacity. Well illustrated, the catalog lists performance curves, characteristics, construction and adjustment of the meter. General Electric Co.

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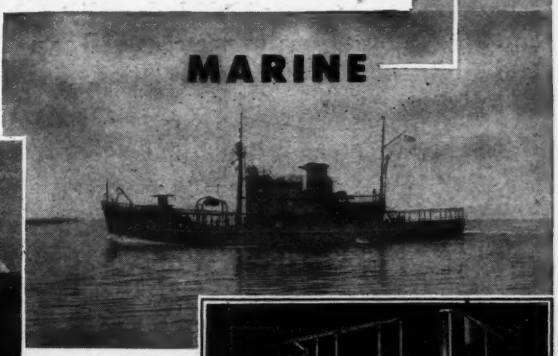

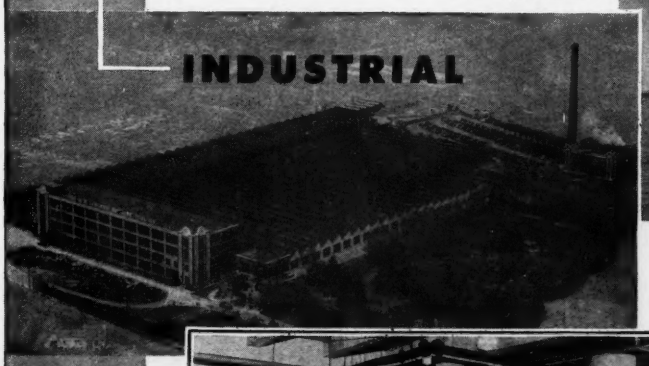

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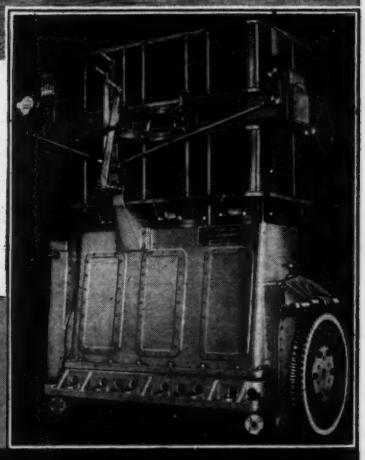

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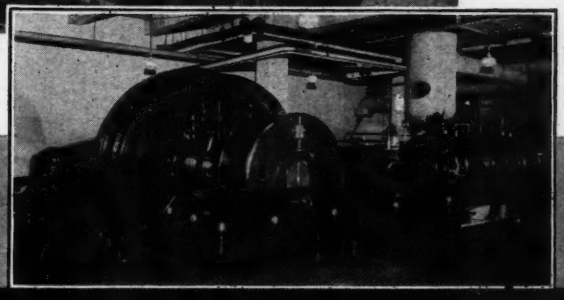

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12 Panelboards—Bulletin No. 67 illustrates and describes circuit breaker panelboards. Included are tables of sizes of the various types and price lists. The bulletin is well illustrated with photographs and drawings. Frank Adam Elec. Co.

13 Oil Circuit Breakers—Catalog 3350 illustrates and describes classes 150-TCR-3 and 250-TCR-3 15,000 v. oil circuit breakers for indoor service. Various sizes of breakers with their interrupting ratings, closing and tripping currents, amount of oil required and approximate shipping weights, control diagrams, methods of tripping, and dimensional data are included. Roller-Smith Co.

Belting

14 V-Belts—Simplifying the problem of selecting correct V-belt drives for wartime applications is the theme of Texrope V-Belt Drive Bulletin B6051-C. Given are simplified charts and tables for quick selection of these vitally important power transmission units. This bulletin also serves as a key to the number of belts, belt section, belt length, the motor sheave and driven shaft sheave diameters for determining proper V-belt drives. Stock sizes, dimensions and construction details are also included for all Texrope Drives. Allis-Chalmers Mfg. Co.

15 Conveyor Belt Repair—An illustrated step-by-step procedure for making repairs on conveyor belts by the use of portable electric vulcanizers is the feature of a new booklet, entitled, Rubber Conservation for Users of Industrial Rubber Belting. The general theme of the booklet deals with the saving of rubber in the plant and gives interesting examples on rubber conservation. The B. F. Goodrich Co.

16 Conveyor Belting Conservation—An 11 by 14 in. placard which may be hung up conveniently in a conspicuous place deals specifically with the proper care of rubber conveyor belting. Listed are do's and don'ts and information on servicing various types of belting. Robins Conveying Belt Co.

Pumps and Valves

17 Centrifugal Pumps—Facts on a complete line of centrifugal pumps are given in 8-p. Bulletin B6059-H. Included in the bulletin are pump types for every purpose—single and double suction, single and multi-stage, mixed and axial flow, combined Allis-Chalmers units and special pumps to solve special problems, and also the recommended applications for the Electrifugal one-package pump unit. Allis-Chalmers Mfg. Co.

18 Concrete Pump—24-p. Bulletin 404 describes the Rex Pumpcrete, a pump that pumps concrete by pipeline for construction jobs, thus eliminating the "lift and carry" method. Included in the bulletin are sections that deal with size and type of work to be done, pipeline handling and facts, questions and answers involved in the use of the Pumpcrete, and dimensions and specifications for various size machines. Chain Belt Co.

19 Valve Repair—6-p. "how to do it" Bulletin No. 5 gives timely hints on repairing and servicing gate and globe valves. Information on regrinding and renewing discs and seats with illustrations is included. Crane Co.

Welding Equipment

20 Control for Welding—A 38-p. illustrated booklet, B-3102, gives a simplified explanation of electronic control for resistance welding, points out the different kinds of resistance welding that can be done, the function of the various controls and the degree of accuracy made possible by electronic control. Also included are application data on the choice and application of a.c. single-phase resistance welding control; an 8-p. bulletin on fundamental electronic circuits; and a discussion of the cathode ray oscilloscope and its application to welding timers. Westinghouse Elec. & Mfg. Co.

21 Welding Electrodes—A 6-p. bulletin, a supplement to the Ampco-Trode Weldrod Bulletin, describes in detail Ampco-Trode 10, an all-purpose coated bronze electrode. Contained are physical properties, chemical composition and procedures for various types of welding using the new elec-

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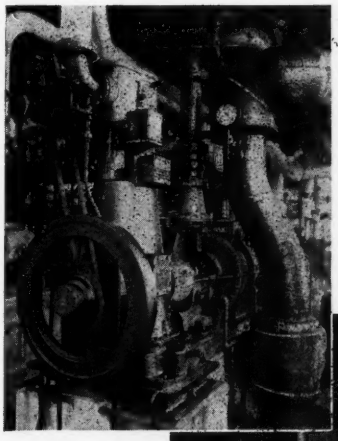

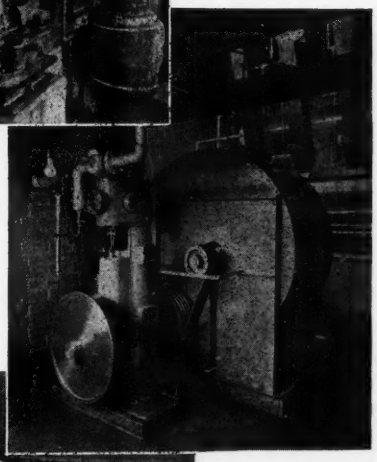

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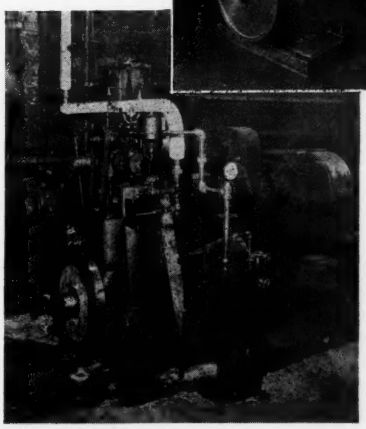

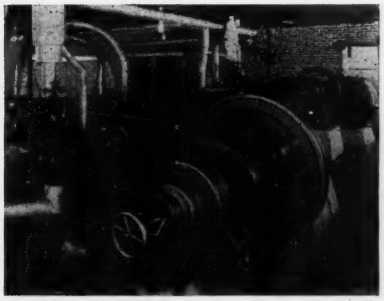

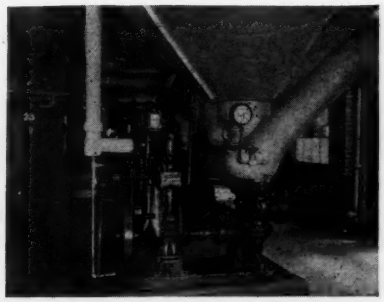

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trode. Also the application for metallic arc welding of cast manganese bronze, Muntz metal, and brass, and also diagrams which show methods of welding, deep groove preparation, building up metal on vertical surfaces, weaving sequence, and method of depositing beads. Ampco Metal, Inc.

Miscellaneous

22 **Diesel-Electric Locomotives** — A new 65-t. Diesel-electric locomotive for industrial switching is described in a handsomely colored 16-p. catalog GEA-3598. Construction features are illustrated together with advantages and savings rendered various industries by this new locomotive. General Electric Co.

23 **Production Indicator**—Produc-Trol, a board which portrays a visual picture of every item handled by any concern, such as men, money, materials and machines, is described in a 4-p. bulletin. From 1 to 50,000 items can be listed with its history and production status. The board is so constructed so that any information concerning any of the items may be had at a glance. Wassell Organization.

24 **Balancing Machines**—A new catalog contains complete descriptions of many Bear Dy-Namic Balancing Machines for balancing armatures, fans, wheels, gears, etc., also concise data on Dy-Namic Balancing and its importance in eliminating noise and premature wear due to excessive vibrations resulting from couple action. Bear Mfg. Co.

25 **Plastic Rubber**—Job Sheet No. 1 describes Malacca Plastic Rubber, a pure gum rubber compound for abrasion resistance, which is used extensively for repair and maintenance of various types of rubber belting. Robins Conveying Belt Co.

26 **Hoists**—Modern Materials Handling Magic is the title of a 16-p. booklet which gives factual information concerning Reading unit constructed electric and chain hoists. The booklet also provides helpful ideas for use in solving materials handling problems. Reading Chain & Block Corp.

27 **Heat Exchangers**—Heat Transfer through Metallic Walls is the title of a 16-p. booklet of technical data and formulae for use in connection with all types of heat exchanger design. Heat transfer data covers copper, red brass, aluminum, mild steel, admiralty metal, lead, nickel, stainless steel, cupro nickel and inconel. Various types of industrial heat exchangers are illustrated and included is an excellent treatise on heat transfer as influenced by metal conductivity, scale, film coefficients and temperatures. The International Nickel Co., Inc.

28 **Unit Heaters**—The first edition of the Standard Code for Testing Hot Water Unit Heaters contains definitions, ratings, testing equipment and procedure, computation of results and recommendations for code equipment and its use. Engineering Committee, Industrial Unit Heater Assn.

29 **Processing Machinery** — Basic machinery for the processing industry is described in Bulletin B6177A. Designed especially to aid the processor in filling his current wartime requirements, the bulletin contains illustrations, diagrams of operating principles, and lists features, sizes and capacities of units which are widely applied in this field. The application of crushing, grinding and milling type reduction, mechanical separation, washing, disintegrating and material handling, and pyro-processing equipment is also included. Allis-Chalmers Mfg. Co.

30 **Fire Protection**—A 11⅛ by 17¼ in. illustrated poster, G-360, stresses the all-out importance of preventing fires by keeping the plant clean. American Mutual Liability Insurance Co.

31 **Self-Locking Nuts**—A wall chart, 21 by 27 in., explaining the uses of various types of self-locking nuts, is being distributed to engineering departments, drafting rooms, maintenance shops, and schools. The center of the chart describes the basic principle in obtaining self-locking action in all Elastic stop nuts, regardless of type. Included are illustrations of advantages of the nuts, and also a presentation of cross-section drawings showing the method of application of the nine types most generally used, with corresponding illustrations of these types. Elastic Stop Nut Corp.

32 **Operating Practices**—101 Suggested Good Operating Practices is the title of a 12-p. catalog which gives intimate details for properly handling packings, insulations,

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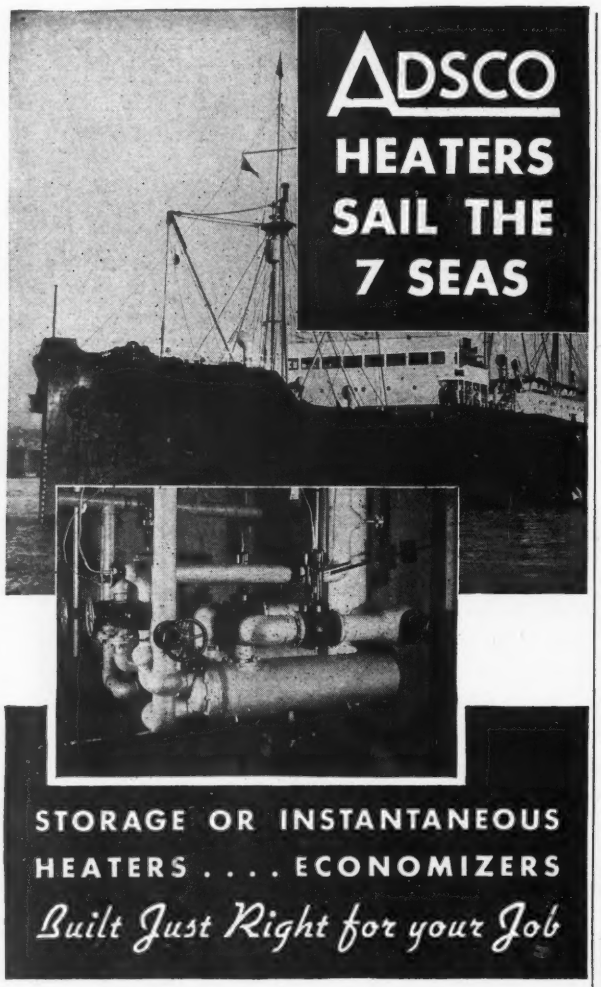

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roofing, friction materials and refractory cements. Included in this data are precautions and advantages involved in applying these materials to their operation. Johns-Manville.

33 **Colloidal Graphite**—A 4-p. informative bulletin, No. 421-YY, describes the use of "dag" colloidal graphite as a lubricant for running-in internal combustion engines, compressors and other mechanical equipment. Acheson Colloids Corp.

34 **Rust Preventing Paints**—A 20-p. catalog on rust preventive paints contains directions for the proper application of rust preventive coatings. Included are descriptions of special coatings, explanations of where and how these materials may be used for maximum protection and illustrations of the products available. Rust-Oleum Paint Corp.

35 **Flooring**—A 4-p. folder entitled Tough Floors with Ruggedwear illustrates how to cover rough concrete or wood floors, platforms, aisleways, ramps and steps; also how to make featheredge patches without chipping out old concrete or ripping up splintery wood. Flexrock Co.

Special Request Bulletins

Metal Parts Washers—The various types of Detrex Washers for use with alkali cleaning compounds, petroleum spirits and emulsion cleaners together with the many features of design and construction incorporated in these machines are illustrated and described in a new 24-p. booklet. Special adaptions of this machinery for defense armament production, particularly in the aircraft industry are included. Four pages of the book are devoted to blue print type of assembly drawings covering in some detail the construction of washers using both belt and monorail conveyors. Requests should be made on company letterhead to Detroit Rex Products Co., 13005 Hillview Ave., Detroit, Mich.

Technical Calendar—A 1943 calendar, 15¾ by 24½ in., has been designed especially for draftsmen and engineers. It is made up into 52 weekly sheets; the numerals are large and easily seen from a distance. Included is technical data and charts on wire and sheet metal gages, screen threads, etc. Requests for this calendar must be made on your company letterhead and addressed to Frederick Post Co., Box 803, Chicago, Ill.

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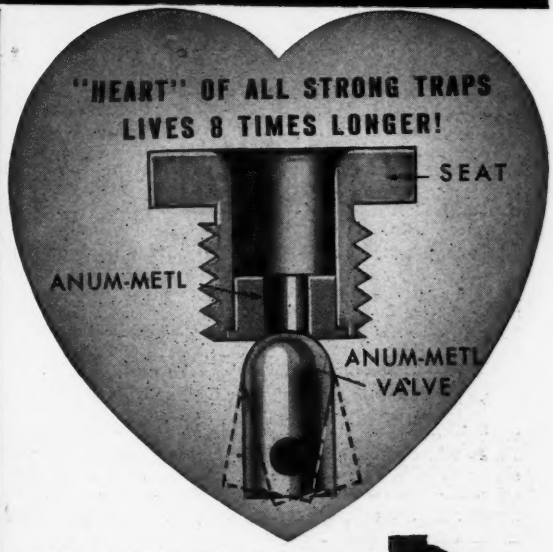

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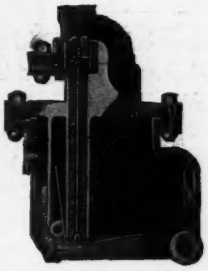

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Power Plant Construction News

Ala., Birmingham—Johnston & Jennings Co., Inc., 877 Addison Rd., Cleveland, O., manufacturer of stokers, vapor equipment, molding machines, etc., plans installation of electric power equipment in new detinning plant in vicinity of Birmingham, for Government production. A power substation will be built. Entire project will cost about $1,000,000, with financing provided by Defense Plant Corp., Washington, D. C. Work will proceed at early date. H. K. Ferguson Co., Hanna Bldg., Cleveland, O., engineer and contractor, will design buildings and supervise erection.

Colo., Colorado Springs—War Department, Washington, D. C., has approved plans for immediate construction of new air force base in vicinity of Colorado Springs, comprising large group of buildings. A boiler plant is planned for central-heating service, and power substation with distribution system for light and power supply. Entire project will cost over $3,000,000, and will be supervised by U. S. District Engineer Office, Omaha, Neb.

Conn., East Hartford—Pratt & Whitney Division, United Aircraft Corp., East Hartford, manufacturer of aircraft engines and parts, plans installation of electric power equipment in new 2-story addition. Cost reported over $300,000. Albert Kahn Associated Architects & Engineers, Inc., New Center Building, Detroit, Mich., is architect and engineer. Work will be placed under way at once.

La., Baton Rouge—Firestone Tire & Rubber Co., Akron, O., plans power plants at new synthetic rubber mills in vicinity of Baton Rouge and Lake Charles, respectively. Plans will comprise several large 1 and multi-story processing and production buildings, and auxiliary structures for miscellaneous service. Electric power equipment will be installed. Entire project is reported to cost over $3,500,000. It is understood that financing will be provided by Defense Plant Corp., Washington, D. C. H. K. Ferguson Co., Hanna Building, Cleveland, O., engineer and contractor, will design plants and supervise erection.

Minn., Osseo—Farm Valley Foods, Inc., care of H. G. Hornibrook, head of Apex Oil Products Co., 100 Seventeenth Ave. North, Minneapolis, recently organized by Mr. Hornibrook and associates, plans installation of electric power equipment in new 1-story and basement dehydrating plant, 60 by 275 ft., at Osseo, near Minneapolis, for handling potatoes and other vegetables. A boiler house will be built. Entire project is estimated to cost over $100,000. Adolph Meyer, Baker Building, Minneapolis, is consulting engineer.

N. J., Port Reading—Reading Co., Reading Terminal Bldg., Philadelphia, Pa. (Philadelphia & Reading Railway), has approved plans for new boiler house at car and locomotive shops, Port Reading. Cost reported close to $50,000, with boilers and other equipment.

N. J., Ringwood—Alan Wood Steel Co., Conshohocken, Pa., producer of pig iron, and other iron and steel products, affiliated with Koppers Co., Koppers Bldg., Pittsburgh, Pa., plans installation of electric power equipment in connection with expansion and improvements in iron ore mining plant, vicinity of Ringwood. Work will include a number of new buildings, with installation of mining machinery and equipment. Entire project reported to cost over $1,000,000.

New York—War Department, Washington, D. C., has authorized new military cantonment in Rockland County (exact location withheld), consisting of a large number of buildings, with shops, warehouses, etc. Electric power equipment will be installed. A boiler house is planned for central-heating service, with power substation and distribution system for light and power supply. Entire project will cost over $5,000,000, and will be supervised by U. S. District Engineer Office, 120 Wall St., New York, N. Y. Tuttle, Seelye, Place & Raymond, 101 Park Ave., New York, are architects and engineers.

North Carolina—War Department, Washington, D. C., has authorized new military cantonment in Richmond

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County (exact location withheld), consisting of a large group of buildings, with shops, warehouses and other industrial structures. Electric power equipment will be installed. A boiler house and power substation are planned. Complete project will cost over $5,000,000, and will be carried out under supervision of U. S. District Engineer Office, Wilmington, N. C. Proposed to begin work soon.

Ohio, Bowling Green—Daybrook Hydraulic Corp., Lehman Ave., manufacturer of hydraulic apparatus, plans installation of electric power equipment in new 1-story L-shaped addition, 60 by 225 ft., and 75 by 80 ft. Cost reported close to $100,000, with machinery. S. P. Stewart & Son, 135 W. Wooster St., Bowling Green, are architects.

Ohio, Toledo—Sun Oil Co., Woodville St. and city limits, plans installation of electric power equipment in new plant at local oil refinery for production of butadiene, a basic ingredient of synthetic rubber, for Government. It will comprise several large processing and production units, with cost reported in excess of $3,000,000. Financing will be provided by Defense Plant Corp., Washington, D. C. Main offices are at 1608 Walnut St., Philadelphia, Pa.

Ore., Arlington—Grain Products, Inc., Arlington, recently organized, care of Edward M. Hulden, president, Port Commission, plans installation of electric power equipment in proposed new industrial alcohol plant on local site on Columbia River. It will comprise several 1 and multistory units, reported to cost over $250,000.

Pa., Phoenixville—War Department, Washington, D. C., has authorized additions to Valley Forge General Hospital, Phoenixville, including installation of complete steam-heating system and electric service facilities. Proposed to increase capacity of boiler house, with installation of additional equipment. Project will be carried out under direction of U. S. District Engineer Office, Philadelphia, Pa.

Tenn., Memphis—Q. O. Chemical Co., Inc., recently organized subsidiary of Quaker Oats Co., 141 W. Jackson Blvd., Chicago, Ill., plans installation of electric power equipment in new multi-unit plant in vicinity of Memphis, for production of furfural, a basic ingredient of synthetic rubber, for Government. A power substation is planned. Entire project is reported to cost over $2,500,000, with financing by Defense Plant Corp., Washington, D. C. Work will begin soon. Vern E. Alden, 120 S. La Salle St., Chicago, is consulting engineer.

Texas, Abilene—War Department, Washington, D. C., has authorized a new air force base in vicinity of Abilene, consisting of a series of buildings for hangars, shops, warehouses and miscellaneous industrial structures. Electric power equipment will be installed. A power substation is planned, with distribution system for electric light and power service. Entire project will cost over $3,000,000, and will be carried out under supervision of U. S. District Engineer Office, San Antonio, Tex. Proposed to begin work soon.

Utah, Brigham City—War Department, Washington, D. C., plans expansion in boiler plant at Bushnell General Hospital, Brigham City, for central-heating service for new additions. Entire project will cost about $1,500,000, and will be supervised by U. S. District Engineer Office, Salt Lake City, Utah.

Wash., Vancouver—Bonneville Power Administration, Portland, Ore., Paul J. Raver, administrator, plans expansion in Ross power substation near Vancouver, to include installation of additional transformers, condensers, switchgear and other equipment. Also, extensions in 115,000-v. transmission line for increase in power supply to station. Entire project will cost about $1,300,000.

W. Va., Clarksburg—Hope Natural Gas Co., 445 W. Main St., L. L. Tonkin, president, plans series of compressor stations for booster service in connection with proposed new welded steel pipe line from natural gas fields in Louisiana and Texas to connection with company system in Kentucky and West Virginia, totaling close to 1000 mi. New line will have rated capacity of 285,000,000 cu. ft. of natural gas daily and is reported to cost over $40,000,000.

Wis., Union Center—Wisconsin Co-operative Creamery Assn., affiliated with Baraboo Valley Creamery Assn., Garry Carter, Elroy, Wis., president, plans boiler house at new milk dehydrating plant at Union Center. It will comprise a main 1 and 2-story structure, 68 by 213 ft., with wing extension, 18 by 70 ft. Electric power equipment will be installed. Work will begin soon. Cost estimated over $150,000. Klinger & Hubbard, 218 S. Barstow St., Eau Claire, Wis., are architects.

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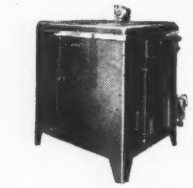

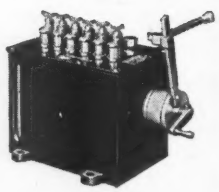

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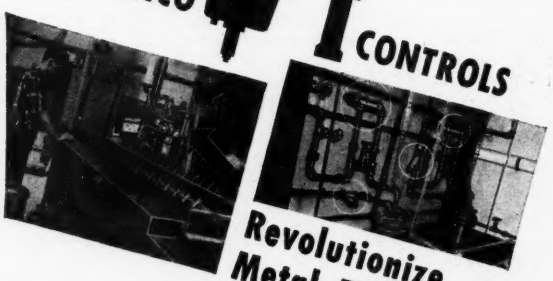

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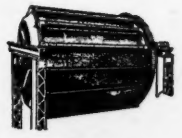

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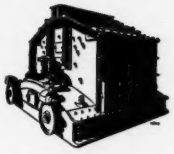

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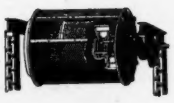

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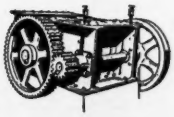

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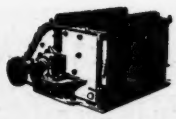

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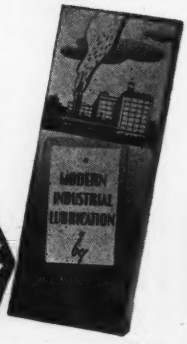

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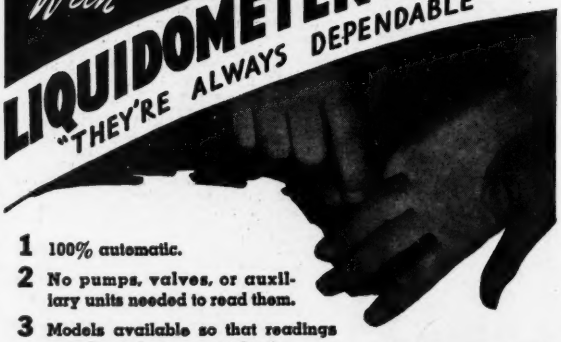

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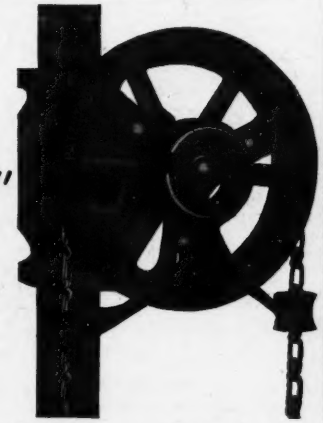

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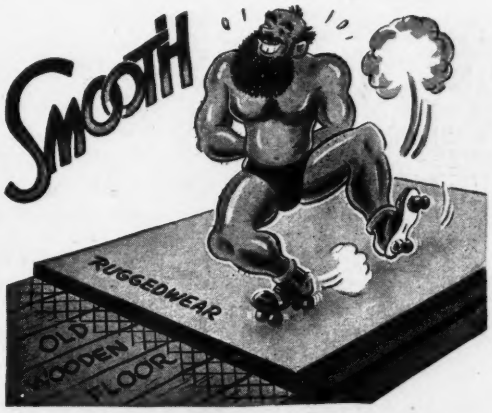

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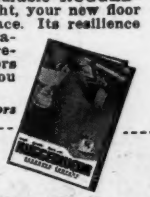

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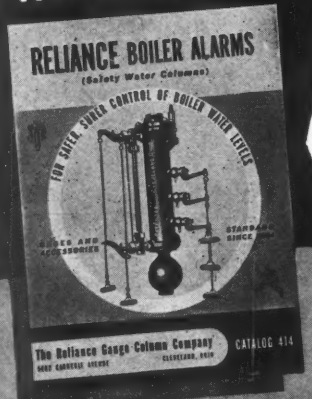

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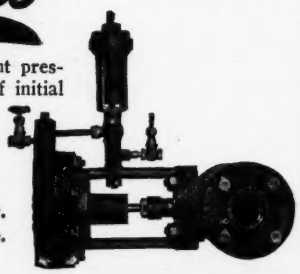

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Cochrane Corporation
Crane Co.
Davis Regulator Co.
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Golden-Anderson Valve Specialty Co.
Nicholson & Co., W. H.
Sarco Company, Inc.
Squires Co., The C. E.
Strong, Carlisle & Hammond Co.
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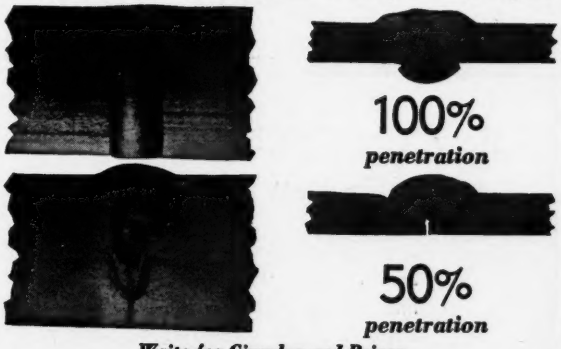

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Cutler-Hammer, Inc.
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VALVES, ACID
Everlasting Valve Co.

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Edward Valve & Mfg. Co., Inc., The
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Chapman Valve Mfg. Co., The
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Cochrane Corp.
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Powell Co., The Wm.
Reading-Pratt & Cady Division of American Chain & Cable Co.
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R-S Products Corp.

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Chapman Valve Mfg. Co., The
Combination Pump Valve Co.
Crane Co.
Edward Valve & Mfg. Co., Inc., The
Fairbanks Company, The
Golden-Anderson Valve Specialty Co.
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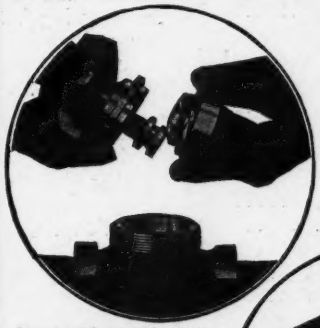

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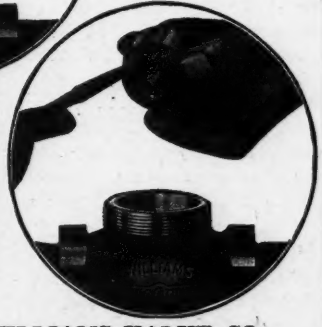

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INDEX TO Advertisers

Airetool Manufacturing Co.... *
Air Preheater Corp..... *
Aldrich Pump Co..... *
Allis-Chalmers Mfg. Co..... *
American Blower Corp.....22-23
American Chain & Cable Co., Inc. 141
American Chimney Corp.....156
American Coal Burner Co.....168
American District Steam Co....166
American Engrg. Company..10-11
American Pulverizer Co.....149
American Radiator & Standard Sanitary Corp.....22-23
Anderson Co., The V. D..... *
Armstrong Machine Works.... 18
Askania Regulator Co..... *
Atlas Lumnite Cement Co., The.134
Atlas Valve Company.....171

Babbitt Steam Specialty Co....173
Babcock & Wilcox Co., The..12-13
Bacharach Ind. Inst. Co.....175
Bailey Meter Co..... 46
Baldwin De La Vergne Sales Corp. ..... *
Baldwin Locomotive Works... *
Bartlett & Snow Co., The C. O.147
Belmont Pkg. & Rubber Co., The 25
Bendix Aviation Corp.....146
Betz, W. H. & L. D..... *
Biddle Co., James G.....115
Bird-Archer Co., The..... 47
Blackmer Pump Co ..... *
Borg-Warner Corp.....127
Bowser & Co., Inc., S. F.....170
Brown Instrument Co., The.... *
Brunt Equipment Co..... *
Burgess Battery Co..... *

Canton Stoker Corp..... *
Carborundum Company, The.. *
Cash Company, A. W.....155
Chapman Valve Mfg. Co., The .....Inside Back Cover
Cities Service Oil Co.....145
Coal Bureau of Upper Monongahela Valley Association..... *
Cochrane Corporation.....111, 152
Combination Pump Valve Co..150
Combustion Engrg. Co., Inc...4-5
Cook's Sons, Inc., Adam.....172
Corning Glass Works.....126
Crane Co.....133
Crane Packing Company..... *
Cutler-Hammer, Inc..... *

Dampney Company of America, The ..... *
Dart Mfg. Co., E. M.....130
Davis Regulator Co..... *
Dearborn Chemical Co..... 45
DeLaval Steam Turbine Co.... .....156, 180
Detroit Stoker Co..... *
Dowell Incorporated..... *
Dravo Corporation 176

Edward Valve Mfg. Co., Inc., The 107
Ehret Magnesia Mfg. Co..... *
Electric Chemical Co..... *
Elgin Softener Corp..... *
Elliott Co. 2-3
Engineer Co., The.....154
Ernst Water Column & Gage Co.140
Everlasting Valve Co..... *
Exposition of Power & Mechanical Engineering, 15th National 165

Fairbanks Co., The.....162
Falstrom Company 151
Fisher Governor Company.....138
Flexrock Co. 173
Flori Pipe Co., The..... 33
Flynn & Emrich Co..... *
Foster Engrg. Company..... *
Foster Wheeler Corp.....16-17
France Packing Co..... *
Fuller Company 179

Garlock Packing Co., The..... 37
General Coal Company..... *
General Electric Co.....6-7, 24
Gifford-Wood Co. ..... *
Gilmer Company, L. H.....121
Globe Steel Tubes Co..... *
Golden-Anderson Valve Specialty Co. 154
Graver Tank & Mfg. Co., Inc..157
Green Fuel Economizer Co.... *
Grinnell Co., Inc..... *

Haering Co., D. W.....146
Hagan Corporation.....8-9, 28-29
Hall Laboratories, Inc...8-9, 28-29
Hays Corporation, The..... 30
Henszey Company 152
Huyette Co., Inc., The Paul B.. *

Infilco, Incorporated ..... *
International Nickel Co.....109
Iron Fireman Mfg. Co.....38-39

Johns-Manville 44

Keeler Co., E.....125
Kellogg Co., The M. W.....123
Kennedy Valve Mfg. Co., The.139

Leavitt Machine Co.....159
Leeds & Northrup Company... 32
Liquidometer Corp., The.....172
Lummus Co., The..... 34
Lunkenheimer Co., The.....105

Magnolia Metal Co.....148
Manzel Bros. Co.....176
Marley Company, The..... 31
McGraw-Hill Book Co., The...160
Midwest Piping & Supply Co., Inc. 19
Minneapolis-Honeywell Reg. Co. *
Morse Chain Co.....127
Murray Iron Works Co.....144

National Aluminate Corp.....103
National Valve & Mfg. Co..... *
Nicholson & Co., W. H.....148
Northern Equipment Co.....113
Nugent & Co., Inc., Wm. W... *

Peabody Engrg. Corp..... *
Pennsylvania Crusher Co.....171

For handy classified listings of power equipment and supplies see Where-To-Buy directory on preceding pages

Permutit Co., The.....Back Cover
Pipe Fabrication Institute.....131
Pomona Pump Co..... *
Porter & Co., Inc., H. W..... *
Powell Co., The Wm.....135
Pritchard & Co., J. F..... *
Proportioneers, Inc. 41
Quimby Pump Co..... *
Raybestos-Manhattan, Inc..... *
Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc. 141
Reliance Gauge Column Co....174
Rempe Co. 150
Republic Flow Meters Co..... *
Republic Steel Corporation..... *
R. D. L. ..... *
Richardson Scale Company.... *
Ric-Wil Company, The.....167
Roto Company, The.....142
R-S Products Corp.....132
Sarco Company, Inc.....170
Sauerman Bros., Inc.....152
Scovill Mfg. Co..... *
Shell Oil Co., Inc.....129
Simplex Valve & Meter Co....156
Skinner Engine Co.....161
Smolensky Valve Co., The.....174
Smooth-On Mfg. Co.....164
Socony-Vacuum Oil Co., Inc..20-21
Springfield Boiler Co..... *
Squires Co., The C. E.....174
Standard Oil Co. (Indiana)..35-36
Steel and Tubes Division..... *
Strong, Carlisle & Hammond Co.167
Sun Oil Company.....117
Swartwout Co., The..... *
Syntron Company ..... *
Taylor & Co., W. A.....154
Taylor Forge & Pipe Works...137
Taylor Instrument Cos..... 40
Terry Steam Turbine Co.....26-27
Texas Co., The..... 48
Tide Water Associated Oil Co.. *
Treasury Department 153, 158
Troy Engine & Machine Co....163
Tube-Turns, Inc. 119
United States Rubber Co..... *
United States Steel Corp.....134
Vogt Machine Co., Inc., Henry.143
Wahl Refractory Prod. Co..... *
Warren Steam Pump Co., Inc..128
Water Treatment Co. of America ..... *
Watson-Stillman Co., The.....169
Wedge Protectors, Inc.....175
Westinghouse Elec. & Mfg. Co. *
Wickes Boiler Co., The..... *
Williams Gauge Co., The.....158
Williams Valve Co., The D. T..177
Wilson, Inc., Thos. C.....136
Wing Mfg. Co., L. J.....42-43
Worthington Pump & Machy. Corp. ..... *
Yarnall-Waring Co. 14-15, 50

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Firms whose advertising is not in this issue but is appearing in other issues is marked with an *

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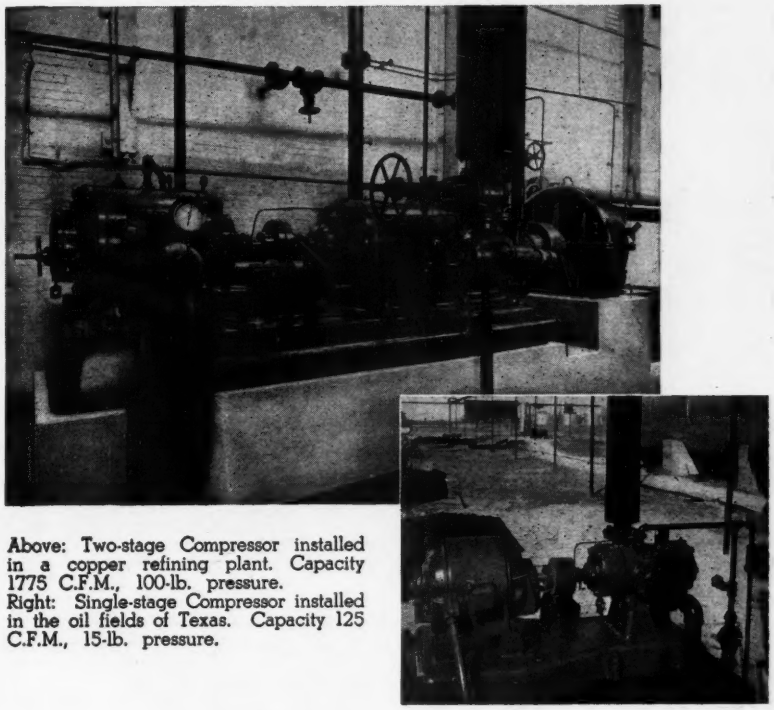

Above: Two-stage Compressor installed in a copper refining plant. Capacity 1775 C.F.M., 100-lb. pressure.
Right: Single-stage Compressor installed in the oil fields of Texas. Capacity 125 C.F.M., 15-lb. pressure.

Single and Two-Stage Units . . . Capacities to 1800 C.F.M., 125-Lb. pressure

There's a Fuller Rotary Compressor that will meet your requirements. Built for direct motor or gas-engine drive without speed reduction, and for geared-turbine drive, they offer dependable service, keep maintenance at a minimum . . . in the long run, lower operating costs. Original capacities maintained for the life of the machine, plus many other inherent advantages, warrant your thorough investigation.

FULLER COMPANY
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Chicago: 1144 Marquette Bldg.
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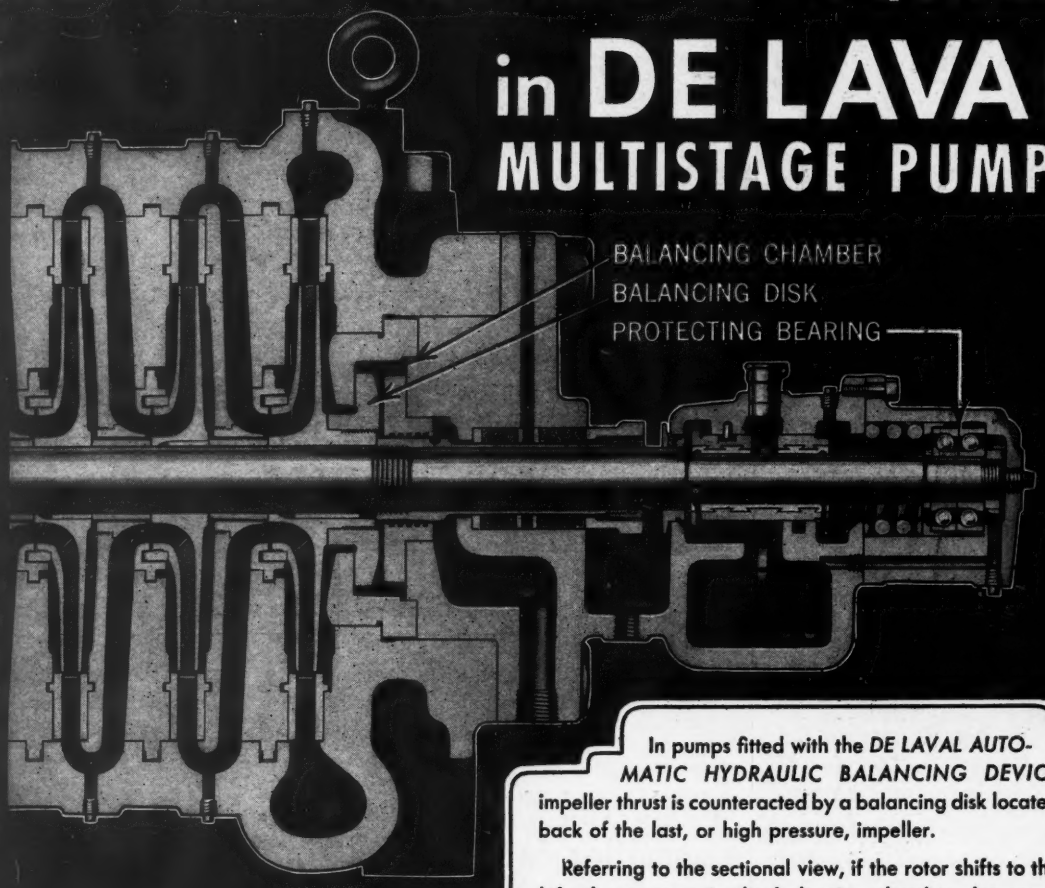
FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

NO THRUST BEARING IS REQUIRED in DE LAVAL MULTISTAGE PUMPS



In pumps fitted with the *DE LAVAL AUTOMATIC HYDRAULIC BALANCING DEVICE* impeller thrust is counteracted by a balancing disk located back of the last, or high pressure, impeller.

Referring to the sectional view, if the rotor shifts to the left, the pressure in the balancing chamber decreases, counteracting the tendency to shift, and vice versa. So long as the pump receives liquid there is no perceptible movement and no contact of the balancing disk with the casing ring.

However, to prevent rubbing in case the pump should be operated dry, a spring-loaded protecting bearing is provided to hold the rotor out of contact with the stationary parts. Normally, it does not come into contact with its positioning shoulder while the pump is running.

Many earlier De Laval pumps having hydraulic balancing, but without the protecting bearing, have for years fed, and still feed, high pressure boilers.

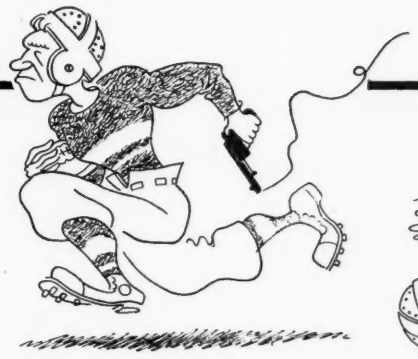
Further discussion of multistage pump design will be found in Catalog P-3621, sent upon request.

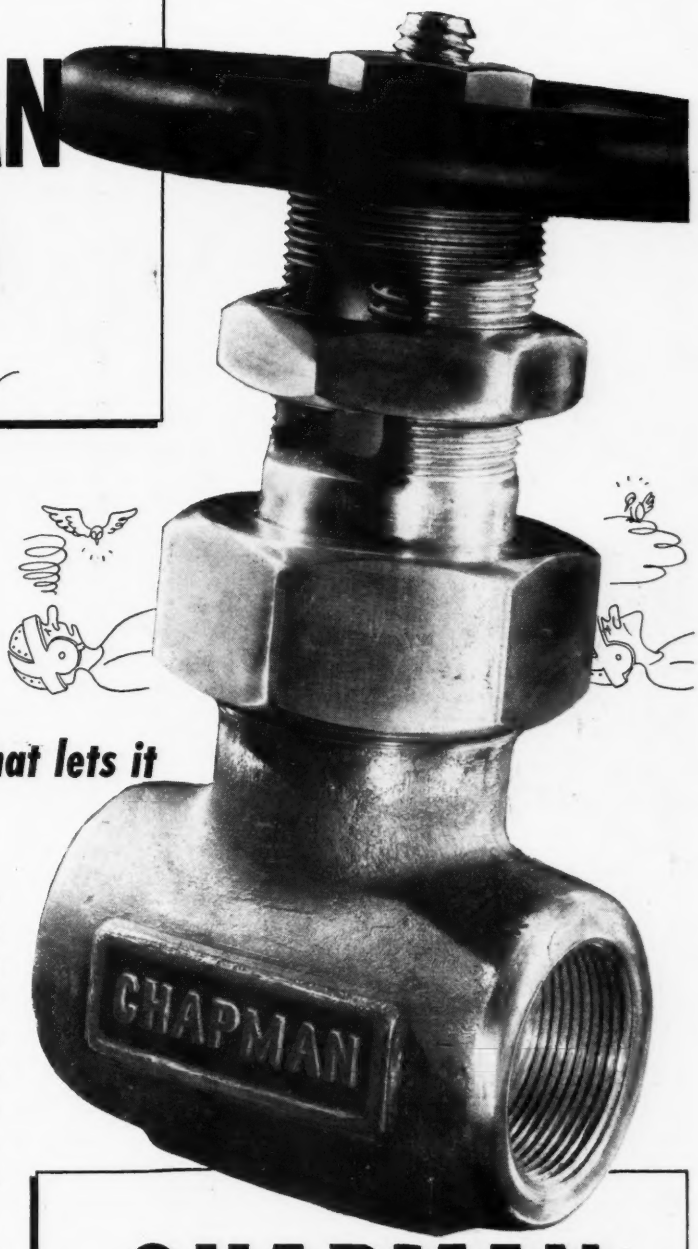
Two turbine-driven and one motor-driven combination boiler feed and condensate pump units; 1455 g.p.m. each against 1186 p.s.i.

DE LAVAL Steam Turbine Co.
TRENTON, N. J.

MANUFACTURERS OF TURBINES · STEAM HYDRAULIC PUMPS · CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT MOTOR MOUNTED, MIXED FLOW, CLOGLESS, SELF PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS · GEARS · WORM, HELICAL and FLEXIBLE COUPLINGS

CHAPMAN
List 960





Packs Extra Protection that lets it Outrun Wear

This forged-steel, small gate valve is *loaded* with tough stuff that you won't find in any similar type of valve. Plugs and seats are stainless . . . *and in addition,* they can be superhardened by a new, exclusive Chapman process that keeps them on the active list far longer than the law of wear has ever allowed before. And that makes List 960 the top small valve for wartime operation, when replacements must be held to an all-time low. You can get it in sizes from ¼" to 2", with either inside or outside rising stem . . . so better get it now, and get all small-valve troubles off your mind for the duration.

The CHAPMAN VALVE MANUFACTURING CO.
Indian Orchard, Mass.

CHAPMAN
LIST 960
the Only Small Steel Gate Valve with Superhardened Plugs & Seats

The harder he works, the lower the output

WHENEVER this man goes to work, operations stand still. He's turbining boiler tubes to remove the scale deposited by hardness in the feedwater. He's seldom seen at plants equipped with Permutit* water conditioning because Permutit reduces water hardness to *zero!* One such plant reports. "In the ten years since installing Permutit, the boilers in our main plant have been turbined only twice for precaution; the other boilers have not been turbined at all." Another writes, "Previously we had to re-tube boilers every three years, but in the six years of our Permutit installation, we have not touched them as they're as good as new."

This sure protection against shutdowns—which may be indefinite now that new tubes are not available—is the result of feedwater treatment that exactly fits individual plant needs. Permutit can supply this because Permutit provides *every* process, including Zeo-Karb*, hot lime soda softeners, deaerating heaters, silica removal, continuous blowoff equipment, etc. If *you* have a water problem, get the benefit of Permutit's thirty years of experience. Write to The Permutit Company, Dept. A1, 330 West 42nd Street, New York, N. Y. In Canada: Permutit Company of Canada, Ltd.... Montreal . . . Toronto . . . Winnipeg . . . Calgary.

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